Printed on Thin Paper for Foreign Circulation.

The Engineer.

NOV 8 1922

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

Vol. CXXXIV.—No. 3487] LONDON: FRIDAY EVENING, OCTOBER 27, 1922 [Price One Shilling By Inland Post 1s. 3d.

PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—

1. GLAZED STONEWARE DRAINAGE PIPES, &c.
2. CAST IRON PIPES, SOCKET and SPIGOT, 15in.
3. RAILWAY WHEEL TURNING LATHES, 48in.
4. D.C. LOW-TENSION THREE-CORE and TWO-CORE CABLES.

Forms of Tender may be obtained from the Director-General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Friday, the 17th November, 1922.

T. RYAN,
Director-General.

502

No. 00489 of 1922.

IN THE HIGH COURT OF JUSTICE. CHANCERY DIVISION. Mr. JUSTICE P. O. LAWRENCE.
IN THE MATTER OF VICKERS LIMITED
and
IN THE MATTER OF THE COMPANIES (CONSOLIDATION) ACT 1908.

Notice is Hereby Given that a Petition was on the 5th October 1922 presented to the High Court of Justice by the above-named Company for the confirmation of an alteration of the provisions of the Memorandum with respect to the Company's objects proposed to be effected by a special resolution of the Company passed and confirmed respectively at Extraordinary General Meetings of the Company held on the 19th July 1922 and the 3rd August 1922 whereby it was resolved that the objects of the Company be extended so as to enable the Company :

To carry on the business of Metal Workers, Iron-masters, Coalowners, Brick Makers, Quarry Owners, Woodworkers, Printers and Refiners.

To acquire, construct, equip, repair, sell and deal in locomotives, tractors, motor cars, aircraft and vehicles of every description.

To acquire, construct, manufacture, repair, sell and deal in explosives, telescopes, sights, optical and scientific apparatus.

To acquire, erect, construct, equip, maintain, work and improve tramways, railways, roads, ways, bridges, tunnels, canals, hydraulic, electric or gas-works, iron, coal or other mines, smelting works and refineries, silica or other brick kilns, cement works and quarries.

To promote the use of aircraft for passengers and goods.

To manufacture, sell and deal in by-products.

To benefit employees. To carry on all or any of the Company's businesses in any part of the world and either as principals, agents, contractors, trustees or otherwise.

With the usual ancillary powers for the above purposes.

A print of the Memorandum of Association submitted to the said Meetings containing the new Sub-Clauses proposed to be inserted will be sent on request to any creditor, secured or unsecured, or any member of the Company and such print of the Memorandum of Association may be inspected at the office of the Company at Vickers House Broadway Westminster or at the offices of the undersigned Solicitors between the hours of 10 a.m. and 1 p.m. on any weekday prior to the 14th November 1922.

AND NOTICE IS FURTHER GIVEN that the said Petition is directed to be heard before Mr. Justice P. O. Lawrence at the Royal Courts of Justice Strand on Tuesday the 14th day of November 1922 and any person interested in the said Company whether as Debenture-holder, Creditor, Policy-holder or otherwise desirous of opposing the making of an Order for the confirmation of the said alteration under the above Act may appear at the time of hearing by himself or his Counsel for the purpose. Any such person is required to give notice in writing on or before the 10th day of November 1922 of his intention so to appear and stating the grounds of his objection to the undersigned Solicitors. A copy of the said Petition will be furnished to any such person requiring the same by the undersigned on the payment of the regulated charge for the same.

Dated this 20th day of October 1922.

LINKLATERS & PAINES,
2, Bond-court, Walbrook, E.C. 4,
Solicitors for the above-named Company.

(L.S.) 500

Administrative County of London.
SOUTH-WESTERN STORM RELIEF SEWER.

The London County Council invites TENDERS for the CONSTRUCTION in TUNNEL of a 7ft. Internal Diameter SEWER, in Brick or Iron, of a total length of about one mile, in the Metropolitan Boroughs of Lambeth and Wandsworth.

The specification, form of Tender, &c., may be obtained on application to the Chief Engineer of the Council at Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £5. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender and shall not have withdrawn the same. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before the payment of the fee.

No Tender received after Twelve Noon on Tuesday, 14th November, 1922, will be considered. The Council does not bind itself to accept the lowest or any Tender.

JAMES BIRD,
Clerk of the London County Council.

616

Bengal-Nagpur Railway Company, Limited.

The Directors are prepared to receive TENDERS for the following :—

(1) BUFFER PLUNGERS and CASES.
(2) STEEL AXLES.

Specifications and forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 23rd October, 1922.

A fee of £1 1s. will be charged for each specification, which will not be returned.

Tenders must be submitted not later than Noon on Thursday, 2nd November, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
T. E. WYNNE,
Managing Director.

589

Bengal-Nagpur Railway Company, Limited.

The Directors are prepared to receive TENDERS for :—

STEEL BOILER TUBES.

Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 24th October, 1922.

A fee of £1 1s. will be charged for the specification, which will not be returned.

Tenders must be submitted not later than Noon on Monday, 6th November, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

By Order of the Board,
T. E. WYNNE,
Managing Director.

602

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Chinese Engineering Notes.

The Wave Transmission of Power.

Progress in Liquid Fuels.

The Marseilles—Rhone Canal.

The Gaseous Fluid Ejector—No. II.

Institution of Mechanical Engineers: Presidential Address.

Strengthening New Holland Railway Pier.

The Newcomen Society.

Care and Maintenance of Diesel Engines.

The Physicist in the Electrical Engineering Industry.

PUBLIC NOTICES

Corporation of Dublin.

The Corporation of Dublin are prepared to receive from the manufacturers of pumping machinery for sewage sludge PARTICULARS, DESIGNS and TENDERS for DUPLICATE ELECTRICALLY DRIVEN UNITS to raise about 75,000 gallons per hour of sludge through a lift of 34ft. Plans of the existing pumping arrangements may be inspected at the City Engineer's Office, 28, Castle-street, Dublin, and at the offices of Mr. J. S. Alford, M. Inst. C.E., 11, Victoria-street, Westminster, S.W. 1, London. Firms desirous of tendering will be supplied with a drawing showing the existing structural arrangements, and a specification of the conditions to be complied with, upon the deposit of Two Guineas at either of the aforesaid offices. The deposit will be refunded on the return of the whole of the documents and the receipt of a bona fide Tender.

Tenders, sealed and endorsed on the envelope "Tender for Sludge Pumps," are to be addressed to the Chairman of the Streets Committee, 26, Castle-street, Dublin, and must be forwarded so as to reach him not later than Noon on Tuesday, 21st November, 1922.

JOHN J. MURPHY,
Town Clerk.
Dublin, 13th October, 1922. P6309

Plymouth Corporation.
(GAS DEPARTMENT.)

The Gas Committee are prepared to receive TENDERS for an additional ELECTRIC CRANE, GRAB and STORAGE HOPPERS, to be erected at Corporation Wharf, Pottery Quay, Devonport.

Copies of specification and general conditions can be obtained and plans inspected on application to the undersigned.

Sealed Tenders, addressed to the Chairman of the Gas Committee and endorsed "Coal-handling Plant," must be delivered to R. J. Pittall, Esq., Town Clerk, Municipal Buildings, Plymouth, not later than November 11th, 1922.

The lowest or any Tender not necessarily accepted.

W. P. TERVET,
Engineer and Manager.
Gasworks, Devonport, 607

Romford Rural District Council.
RIVERSIDE SEWERAGE.
CONTRACT No. 4.
PUMPING MACHINERY, AUXILIARY PLANT, &c.

The Council are prepared to consider TENDERS from approved makers of sewage pumping machinery for the CONSTRUCTION and ERECTION at their proposed Outfall Works adjoining Rainham Creek, Parish of Hornchurch, Essex, of the PUMPING MACHINERY and other PLANT required.

The Contract includes :—Centrifugal Pumps, Vertical Semi-Diesel Engines, Overhead Travelling Crane, Sludge Ejectors, Pipe Work, and all Auxiliary Plant and Accessories.

The whole will be let in one contract and all the principal parts must be British manufacture.

The general conditions, specification and drawings may be inspected at the office of the Consulting Engineer, Mr. William Fairley, M. Inst. C.E., Parliament Mansions, Westminster, S.W. 1, and a limited number of copies of the specification are available for issue to pump makers direct, on deposit of crossed cheque for £5 5s., made payable to the Council, which deposit will be returned on receipt of a bona fide Tender.

Tenders to be lodged with the undersigned on or before Monday, the 27th day of November, 1922.

The Council do not bind themselves to accept the lowest or any Tender.

T. W. A. GREENHALGH,
Clerk to the Council.

24th October, 1922.
18a, South-street,
Romford, Essex. 605

PUBLIC NOTICES

State Electricity Commission of Victoria.
TENDERS FOR PLANT.

TENDERS are hereby INVITED for the SUPPLY, DELIVERY, &c., of the following for the Morwell Power Scheme.

Copies of Tender form and specification may be obtained or inspected upon application to :—

Agent-General for Victoria,
Melbourne-place, Strand,
London, W.C. 2.

SPECIFICATION No. 23/4.—STEAM TURBINE-DRIVEN BOILER FEED PUMPS.

CHARGE.—£1 1s. for the first two copies of Tender form, conditions of contract and specification complete. These charges will be returned on receipt of a bona fide Tender. A third and any further copies will be supplied for the sum of 10s. 6d. each.

PRELIMINARY DEPOSIT.—A preliminary deposit of £25 is required to be lodged with Tender.

The Commission does not bind itself to accept the lowest or any Tender.

Tenders, on prescribed form, properly endorsed and addressed, must be delivered to the undersigned in Melbourne not later than 5 p.m. on 10th January, 1923.

R. LIDDELOW,
Secretary.
State Electricity Commission of Victoria,
Melbourne, Victoria, Australia. 582

The Royal Borough of Kensington.
PURCHASE OF ROAD ROLLER.

The Council of the above Borough are prepared to receive TENDERS for the SUPPLY of a TEN-TON (nominal weight) COMPOUND STEAM ROAD ROLLER.

Further particulars can be obtained at the office of the Borough Engineer and Surveyor at the Town Hall, Kensington, W. 8.

Tenders, sealed and endorsed "Tender for Road Roller," must be delivered at the office of the undersigned not later than Monday, the 13th November, 1922.

The Council do not bind themselves to accept the lowest or any Tender.

(Signed) WM. CHAMBERS LEETE,
Town Clerk.
Town Hall, Kensington, W. 8,
24th October, 1922. 609

The Great Indian Peninsula Railway Company.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely :—

No.		Fee for Specification.
1.	GALVANISED STAMPED STEEL MORTAR PANS	5s.
2.	CARRIAGE DOOR HANDLES, HINGES, &c.	10s.
3.	SIEVES, &c.	7s. 6d.
4.	LAMP GLASSES, &c.	2s. 6d.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Galvanised Stamped Steel Mortar Pans," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 7th November, 1922.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.
Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 25th October, 1922. 608

PUBLIC NOTICES

County Borough of Halifax.
ELECTRICITY DEPARTMENT.

The Tramways and Electricity Committee of the Halifax Corporation have FOR SALE the following :—

2 BABCOCK and WILCOX WATER-TUBE BOILERS, complete with CHAIN-GRATE STOKERS.

The above-mentioned boilers may be inspected at the Corporation's Power Station, Foundry-street, Halifax, by arrangement, and full particulars obtained on application to Mr. W. M. Rogerson, M.I.E.E., Borough Electrical Engineer, 29, Northgate, Halifax.

Tenders for the above plant should be delivered to the Town Clerk, Town Hall, Halifax, not later than Saturday, November 4th next.

The highest or any Tender not necessarily accepted.

By Order,
PERCY SAUNDERS,
Town Clerk.
Town Hall, Halifax,
6th October, 1922. 483

State Electricity Commission of Victoria, Australia.
COMBUSTION ENGINEER.

APPLICATIONS are INVITED for the POSITION of COMBUSTION ENGINEER in the Mechanical Engineer's Section from engineers having sound engineering training and extended experience in the economical burning of fuel with mechanical stokers in large water-tube boilers installation and well versed in the technology of fuel combustion and steam practices. Applicants should be methodical and keen, able initiate and direct investigation, and apply results therefrom, and generally direct testing staffs in connection with performance of tests on boiler furnaces, steam turbines, condensing plant, pumps, &c. Headquarters will be in Melbourne. Salary at the rate of £600 per annum, commencing half-pay upon the day of sailing to Australia and full pay from the date of arrival in Melbourne. Travelling expenses for the voyage out will be allowed up to £150.—Applications, tabulating experience in chronological order, stating age and when available, with copies of testimonials, should be submitted not later than Friday, 10th November, 1922, to the AGENT-GENERAL for VICTORIA, Australia, Victoria House, Melbourne-place, Strand, London, W.C. 2. 593

SITUATIONS OPEN

WANTED, an ASSISTANT MANAGER for Small General Engineering Works on Tees-side. Must be a capable engineer and experienced in estimating and interviewing.—Address, with references and stating salary required, 580, The Engineer Office. 580 A

A FIRM of ENGINEERS Established in Calcutta REQUIRE the SERVICES of a capable MANAGER to deal exclusively with the selling side. Must have thorough knowledge of engineering machinery of all kinds. Previous experience in India desirable. Bachelor preferred. Commencing salary £1000 per annum, passage out and home, 3 years' agreement, age not exceeding 40.—Reply, with full details of past experience, copies only of testimonials, to Box C. 566, c/o Dawson's Advt. Offices, 121, Cannon-street, E.C. 4. 652 A

A LARGE FIRM of IRONFOUNDERS and MAKERS of STRUCTURAL STEEL WORK are DESIROUS of APPOINTING a FIRM or GENTLEMAN as their REPRESENTATIVE in South Wales.

Applicants are required to have an influential connection with Gas, Iron and Steel, Coal, Chemical and other allied undertakings.

The fullest particulars, including sources of reference and scale of remuneration suggested, may be sent to 575, The Engineer Office. 575 A

COMMERCIAL MANAGER WANTED by Makers of Small Oil Engines; thoroughly acquainted with home and export openings, preferably with some electrical knowledge. Investment of some £900 advantageous to qualify directorship.—Address, P6338, The Engineer Office. P6338 A

CONTRACTING ENGINEERS REQUIRE TECHNICAL ASSISTANT, thoroughly experienced in modern practice of Steam and Electrical Power Station Plant. State age, full details of training, and salary required.—Address, 629, The Engineer Office. 629 A

ENGINEER, Mechanical and Electrical, WANTED in large London Brewery, with thorough practical experience, accustomed to organise and control men. Must live near work. State age, with full particulars of experience and salary required.—Address, P6308, The Engineer Office. P6308 A

ENGINEER, Mechanical and General, to Control Plant Maintenance and Development. Experience of Gas Producers, Boilers and Electrical Equipment essential.—Age, details of experience, and salary to HANS RENOLD, Ltd., Burnage Works, Didsbury, Manchester. 603 A

SITUATIONS OPEN (continued) Page II.

SITUATIONS WANTED, Page 2.

PARTNERSHIPS, Page 2.

PATENTS, Page 2.

MACHINERY, &c., WANTED, Page 2.

FOR SALE, Pages 2, 3 and 4.

AUCTIONS, Pages 3 and 94.

PREMISES TO LET OR WANTED Page 3.

WORK WANTED, Page 4.

AGENCIES, Page 2.

MISCELLANEOUS, Page 2.

For Advertisement Rates See Page 443, Col. 1.

NUMERICAL INDEX TO ADVERTISEMENTS Page 93.

SITUATIONS OPEN (continued)

MACHINE TOOL ENGINEER WANTED for Australia, to Supervise Showrooms. Salesmanship experience an advantage.—Address, stating qualifications and salary, 595, The Engineer Office. 595 A

STEEL CASTINGS.—BRITISH AGENTS Leading Continental Manufacturers, well known in British market, REQUIRE YOUNG MAN with technical experience to Undertake Sales. Applicant accustomed to dealing with railway companies and engineering concerns preferred.—State age, salary, and experience to Z. D. 304, c/o Deacon's, Leadenhall-street, E.C. 3. 598 A

THE DIRECTORS of the LANGLOAN IRON and CHEMICAL CO., Ltd., of Coatbridge, invite APPLICATIONS in strict confidence for the POSITION of GENERAL MANAGER of their business. The works embrace five coal blast-furnaces, with ore briquette, residuals recovery, and cement making plants.

Applicants will please address the CHAIRMAN of the COMPANY, before November 6th next, stating age, scientific qualifications, actual experience in practical management of works, general commercial training, and lowest remuneration entertained.

Testimonials not required in the first instance, but references, from whom inquiries can be made, may be given. P6265 A

WANTED, DRAUGHTSMAN of Mature Experience in Elevating and Conveying Machinery, Crushing and Grinding Plants. Single man preferred. State age, experience, and wages required, and when at liberty.—Address, 623, The Engineer Office. 623 A

WANTED, First-class TRAMCAR DRAUGHTSMAN, capable of dealing with Trucks, Underframes, and full-size Body Lay-out, also General Detail Work. Works, Yorkshire.—Address full particulars re experience, salary, &c., 597, The Engineer Office. 597 A

WANTED for Engineering Firm in the Midlands, DRAUGHTSMAN, used to Power Station Layouts and Constructional Steel Work. State age, experience, and salary required.—Address, 631, The Engineer Office. 631 A

WANTED, JUNIOR DRAUGHTSMAN. Experienced in Agricultural Machinery Work. Send particulars, with references and salary required.—Address, P6318, The Engineer Office. P6318 A

WANTED, TWO or THREE DRAUGHTSMEN. Must have thorough knowledge of Designing Coal Screening Plants. Wages £5 to £6 per week, according to merit.—Address, 630, The Engineer Office. 630 A

CONSTRUCTIONAL DRAUGHTSMAN, for S.W. Lancashire, fully experienced; must be good organiser and able to supervise.—Address, with full particulars, in confidence, 624, The Engineer Office. 624 A

DRAUGHTSMAN, Experienced in Design of Pulverising Machinery or Coal-burning Plant. Give full particulars and wages are and salary required.—Address, 622, The Engineer Office. 622 A

DRAUGHTSMAN, Fully Qualified, WANTED experienced in the Design of Cold-starting Heavy Oil Engines, by old-established firm in the Midlands.—Write full particulars, stating salary, Box 870, Sells' Advertising Offices, Fleet-street, E.C. 4. 539 A

DRAUGHTSMAN WANTED, with Experience in Designing Printing Machines. State experience, technical qualifications, age, and salary required.—Address, P6304, The Engineer Office. P6304 A

JUNIOR DRAUGHTSMAN REQUIRED, who has had experience in Machine Tool Design. Send particulars, with references and salary required.—Address, P6317, The Engineer Office. P6317 A

LONDON.—LTD. CO., Manufacturing Engineers, Motor Cycles, Power Units, Motor Engines, &c., trade £68,147, capital £19,000, own freehold works, REQUIRE DRAUGHTSMAN; invest £1000 ord. shares. Salary £416 and dividend, about 15 per cent. Audited balance sheets for inspection. Refs. req.—Messrs. TITCHFIELD, 23, Great Titchfield-street, Oxford-street, London. 633 A

FITTING SHOP FOREMAN WANTED for Engineering Works in North-East England. Charge of Fitting Shop and Maintenance of all Machinery.—Address, 584, The Engineer Office. 584 A

HEAD FOREMAN REQUIRED, with Extensive experience in modern methods of Chassis Production. State age, full experience, and wages required. London area.—Address, P6314, The Engineer Office. P6314 A

PROGRESS CLERK or CHASER REQUIRED, with extensive experience in modern methods of Chassis Production. State age, full experience, and wages required. London area.—Address, P6315, The Engineer Office. P6315 A

SITUATIONS WANTED

AS WORKS MANAGER. Thoroughly Practical, Well-educated Engineer, sound shop and D.O. experience, loco., steam, general engineering, millwrighting, foundry and repair work. Past 23 years successful control of labour as foreman and works manager.—Address, P6277, The Engineer Office. P6277 B

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-st., E.C. 565 B

CHEMICAL ENGINEERING.—ADVERTISER (26) DESIRES POST as Draughtsman or Assistant Engineer; tar and by-products plant, chemical and structural work; technical training, 7 yrs. D.O.—PERFECT, "The Cranny," Penn, High Wycombe. P6327 B

CIVIL ENGINEER, A.M.I.C.E., Public School, 39, married, two children, fed up with conditions of service in India, taking long leave in May, 1923, with object of getting permanent work in England. Experience 3 years waterworks in England, spent in tunnelling, pit sinking, pipe laying, preparation specifications and quantities, 15 years in India in charge survey, design and construction of large masonry weirs and earthen dams, river training and other works. Ready to take small salary at first in hope of full value within year; outdoor work preferred. Could invest £1500 in a junior partnership.—Apply, ADVERTISER, 54, Parliament-street, S.W. 1. 601 B

ELECTRICAL ENGINEER, 12 Years' Practical, D.O., and commercial experience, charge of men and plant, power transmission, D.C. and A.C. systems, SEEKS NEW POST; moderate salary.—Address, P6326, The Engineer Office. P6326 B

ENERGETIC ENG. (23), Prac., D.O. and Sea-going exp., SEEKS POST with PUBLISHERS, where knowledge of press work could be acquired and services in spare time, capacity would be utilised. Clever and reliable.—C. M., 19, Southside-road, Birkenhead. P6310 B

ENGINEER (31), Experienced, Energetic, Well educated, DESIRES POSITION at home or abroad; 1st cl. B.O.T., knowledge of Spanish.—Address, J. BARRIE, Sundhope, Selkirk. P6305 B

FOUNDRY MANAGER (Metallurgist, Non-ferrous), specialty anti-corrosive products, OPEN for ENGAGEMENT with first-class firm of engineers and founders.—Address, P6306, The Engineer Office. P6306 B

SITUATIONS WANTED (continued)

MANAGER (M.I. Mech. E.) DESIRES POSITION, home or abroad; wide practical and commercial experience.—Address, P6333, The Engineer Office. P6333 B

MECH. and ELEC. ENGINEER (26), Single, A.M.I. Mech. E., A.M.I.E.E., expert on Diesel and all classes of int. com. engines, experienced engineer in steam and elec. plant, D.O., structural and loading plant, railway, locos., rolling stock, workshop and all mining plant, last post 9 years chief engineer of large mining co. abroad, SEEKS ENGAGEMENT, home or abroad. Energetic and sound constitution.—Address, P6299, The Engineer Office. P6299 B

RETD. COMMISSIONED ENGR., R.N. (40), physically fit and energetic, DESIRES POST; conversant with all classes of machy. and blrs.; keep same in efficient state; home or abroad.—BERRY, 49, Ophir-road, Portsmouth. P6330 B

SUGAR PLANT.—Expert ENGINEER DRAUGHTSMAN WANTS APPOINTMENT, assisting colonial engineer, structural steel work and general engineering.—CANE, 2, Clifton-terrace, Malvern Link. P6341 B

THOROUGHLY Experienced LOCOMOTIVE EXPERT, held superintendent's position on railways, erected and ran works, SEEKS APPOINTMENT of Manufacturers' Representative of London office or other suitable post. Excellent record and experiences, age 34; languages, French, Spanish, Portuguese; service abroad if necessary.—Address, P6334, The Engineer Office. P6334 B

WORKS MANAGER of Large Motor Works in Midland Counties for the past four years REQUIRES similar POST or as ASSISTANT MANAGER to leading concern; expert in modern tooling methods for low cost and accurate production; 17 years' experience with leading concerns, M.I.A.E., M.I.P.E.—Address, P6334, The Engineer Office. P6334 B

EMPLOYERS.—MECHANICAL DRAUGHTSMAN (27) DESIRES FRESH START in D.O. Has been draughtsman on art work for past 2½ years, but has kept touch with engineering work; 5 years' pre-war practical shops and D.O. experience, and 4 years' war service as Army mech. draughtsman. Good theoretical knowledge (maths., mechanics, heat engines, steam, &c.); conscientious and hard worker. Would commence low salary or accept fair trial. Resident London.—Address, P6325, The Engineer Office. P6325 B

YOUNG, Keen, Energetic and Ambitious ENGINEER SEEKS CHANGE of BERTH. Practical and D.O. experience, good education, and studying at present for A.M.I.M.E. Preferably position with responsibility and advancement.—Address, P6311, The Engineer Office. P6311 B

AERONAUTICAL ENGINEER and DRAUGHTSMAN (31), with six years' shop and nine years' D.O. experience, DESIRES POSITION in aircraft firm, preferably in or near London, but not essential if post is permanent; excellent refs.—Address, P6316, The Engineer Office. P6316 B

CHIEF DRAUGHTSMAN (32) DESIRES POST as DRAUGHTSMAN or CHIEF. First-class experience in steam and electrical power plant design, layout, factory plant lay-out, building construction, machine design, experimental engineering, estimating drawing-office and labour control, correspondence, &c.—Address, P6332, The Engineer Office. P6332 B

DRAUGHTSMAN, Advanced Junior, 6 Yrs. D.O., 3 yrs. technical, DESIRES POST AT ONCE; any capacity for more experience, temporarily or permanent; well recommended; general engineering knowledge, good tracer.—T., 44, Herbert-gardens, Willesden, N.W. 10. P6329 B

ENGINEER MILLWRIGHT, Work in Wood or Iron, twenty-five years' high-class varied experience in the erection and maintenance of plants, SEEKS SITUATION.—Address, P6340, The Engineer Office. P6340 B

ENGINEERS' SHOP FOREMAN SEEKS ENG., home or abroad; lately with leading shoe, firm; well up in repairs to shoe., conf., preserve and flour mill machinery, &c.—Address, P6331, The Engineer Office. P6331 B

BOILERMAKER Well Up in Boiler and Fire-box Repairs, SEEKS EMPLOYMENT; ex-Service.—F. C., Smith's Library, Dorchester. P6241 B

FITTER (21) SEEKS SITUATION as IMPROVER, 5 years' apprenticeship as fitter in pumping machinery works, refs., country preferred.—Address, P6322, The Engineer Office. P6322 B

MARKER OFF.

FIRST-CLASS MAN, Age 31, Experienced All Classes work.—JOHNSON, 1, Wellington-rd., Nantwich. P6328 B

TRAINED NURSE SEEKS POST in Engineering or other works in or near London.—Apply, J. W., 38, Circus-road Mansions, St. John's Wood. P6300 B

PARTNERSHIPS

ENGINEERING PARTNERSHIPS AND BUSINESSES.

Wheatley Kirk, Price & Co.,
46, Watling Street, London, E.C. 4.

Established seventy years.

A. M.I.C.E. (36), Public School Education, SEEKS PARTNERSHIP with established firm consulting engineers or contractors with overseas connections. Sound experience, capital to £10,000.—Address, P6260, The Engineer Office. P6260 C

ENGINEER, 13 Years' Experience, Hydraulic, I.C., motors and contract work, would ENTERTAIN PARTNERSHIP in sound business; home counties preferred. Highest references given and required. Capital part down, remainder in 12 months.—Address, P6337, The Engineer Office. P6337 C

EX-OFFICER DESIRES to INVEST £2000 on First Mortgage Debenture at fixed rate of interest in any sound company which can utilise full-time services at salary.

Accountant's investigation required.

Write, Box 28, Wilson Bell Publicity, Ltd., 83, Pall Mall, S.W. 1. P6319 C

MISCELLANEOUS

TO MARINE ENGINEERS, SHIPBUILDERS, OWNERS.

A MARINE OIL ENGINE DESIGNER Offers to DEVELOP Main or Auxiliary OIL ENGINES and LAY OUT ENGINE-ROOMS, which will be an advance on present practice in reliability, cost, space and weight. No expensive licence or experimenting. Address, P6339, The Engineer Office. P6339 I

WANTED, TENDER for the SUPPLY and/or ERECTION of STEEL STRUCTURE with galvanised sides and roofing, for motor 'bus garage in Bangor, North Wales. Either second-hand or new structure, size about 90ft. by 90ft.—AVERY and ROBERTS, Ltd., 81, Renshaw-street, Liverpool. 628 I

EDUCATIONAL

A BROCHURE on "ENGINEERING SALESMANSHIP and SALES MANAGEMENT," with particulars of a SPECIAL COURSE of TRAINING, will be sent post free on application to SECRETARY, THE INSTITUTE OF ENGINEERING SALESMANSHIP, 333, Oxford-road, Manchester. P6196

CORRESPONDENCE COURSES for Inst. C.E., Inst. Mech. E., London Univ. (Matric., Inter., and B.Sc.) personally conducted by Mr. TREVOR W. PHILLIPS, B.Sc. (Honours), Assoc. M. Inst. C.E., M.R.S.I., F.R.S.A. &c. Also Day Tuition in Office. Excellent results at all Exams. Courses may commence at any time.—6/11, Trafford Chambers, 58 South John-street, LIVERPOOL. Ex. B

INST. C.E., Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS.—Mr. G. P. KNOWLES, M.B.E., B.Sc., A.M. Inst. C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Thousands of successes during the past sixteen years. Course can be commenced at any time.—39, Victoria-street, Westminster S.W. Telephone No., Victoria 4790. Ex. B

LEARN SURVEYING AND LEVELLING.—Thorough practical instruction given by an expert.—Address, E. MOUL (late L.S.W. and S.P.D. Rlys.) Hollybank, Woking. P6221 B

PREPARATION for City and Guilds Matric., Students, A.M.I.C.E., and B.Sc. (Eng.) Examinations by experienced coaches. Numerous successes.—Apply for prospectus, THE GENERAL ENGINEERING COLLEGE, 2, Penywern-road, Earl's Court. P6201 B

THE HULL CORPORATION is Prepared to Receive a PUPIL in the CITY ENGINEER'S DEPARTMENT. He will be required to comply, as far as practicable, with the recommendations of the Institution of Civil Engineers. Premium (payable to Corporation) about £100.

Apply, CITY ENGINEER, Hull. P6301 B

TUITION BY POST.—Inst. C.E. and I. Mech. E. Enrol now for next Exams.; 100 per cent. passes last examination. Reinforced Concrete, new comprehensive course under expert engineer, £3 3s. Write for particulars.—PENNINGTONS, University Tutors, 254 Oxford-road, Manchester. Estab. 1876. Ex.

PATENTS

INVENTIONS DEVELOPED, PATENTED, and SOLD for Clients by Engineers (late of Vickers Ltd., B.Sc., M.E. Ae. S., A.M.I. Ae. E.). Strictest confidence, most moderate terms.—FORTIS and PARTNERS, 60, Queen Victoria-street, E.C. 4. Tel., Cent. 3564. 512 E

THE PROPRIETOR of BRITISH PATENT No. 15,564/11, for "A New or Improved Manufacture consisting of a Cooked Digestible Chocolate and the Machinery and Process for Producing same," DESIRES to INTRODUCE his INVENTION to the notice of manufacturers and others with a view to the invention being worked commercially under LICENCE or otherwise.—All communications to be addressed to JENSEN and SON, Chartered Patent Agents, 77 Chancery-lane, London, W.C. 2. 536 E

THE OWNERS of PATENTS Nos. 102,634 of 1914, for "Improvements in Multi-cylinder Motors with Radially Arranged Cylinders;" 113,406 of 1917, for "Improvements relating to Internal Combustion Engine Cylinders;" 116,150 of 1917, for "Improvements relating to Pumps;" 128,652 of 1917, for "Improvements relating to Internal Combustion Engine Cylinders;" 125,053 of 1917, for "Improvements relating to Internal Combustion Engine Valve Mechanism;" 132,154 of 1918, for "An Improved Bracket for Supporting Accessories of Internal Combustion Engines;" 140,529 of 1918, for "Improvements in Connecting Rod Big Ends for Internal Combustion Engines;" 140,545 of 1918, for "Improvements in Shock Absorbers for Aeroplane Radiators;" 145,398 of 1919, for "Improvements in Springs for the Valves of Explosion Motors," are DESIROUS of NEGOTIATING with Interested parties for the GRANTING of LICENCES thereunder on reasonable terms.—For information write Messrs. LLOYD WISE and CO., Chartered Patent Agents, 10, New-court, Lincoln's Inn, London, W.C. 2. 560 E

THE PROPRIETORS of BRITISH PATENT No. 134,289, dated October 28, 1918, relating to "Improvements in Vehicle Brakes," are DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed to B. SINGER, Steger Building, Chicago, Illinois. 611 E

THE PROPRIETOR of BRITISH PATENT No. 21,340/14, dated November 12, 1913, relating to "Improvements in Key Locks for Bearing Elements," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed B. SINGER, Steger Building, Chicago, Illinois. 612 E

THE PROPRIETORS of BRITISH PATENT No. 4943 of 1913, for "Improvements in Railway Buffer Stops," are DESIROUS of ENTERING into NEGOTIATIONS for the GRANT of LICENCES thereunder on reasonable terms, or for the SALE of the PATENT outright.—Communications please address to DICKER and POLLAK, 20-23, Holborn, E.C. 1. 598 E

TO ENGINEERS AND MANUFACTURERS OF FILTERING PLANT.—The PROPRIETORS of PATENT No. 136,690 are DESIROUS of ENTERING into NEGOTIATIONS for the GRANT of LICENCES to manufacturers on royalty or otherwise, or to treat for the SALE of the PATENT outright.—Particulars will be furnished on application by A. M. and WM. CLARK, 53 and 54, Chancery-lane, London, W.C. 2. 587 E

THE PROPRIETOR of BRITISH PATENT No. 117,182, dated September 25, 1917, relating to "Improvements in Valves for Internal Combustion Engines," is DESIROUS of ENTERING into ARRANGEMENTS by way of a LICENCE or otherwise on reasonable terms for the purpose of EXPLOITING the above patent and ensuring its practical working in Great Britain.—All inquiries to be addressed, B. SINGER, Steger Building, Chicago, Illinois. 591 E

MACHINERY, &c., WANTED

WANTED, Good Second-hand Belt-driven POWER HAMMER.—Please give full particulars and where it can be seen to MONKS, HALL and CO., Ltd., Warrington, Lancs. P6321 F

WANTED to HIRE or PURCHASE, STEAM SHOVEL, ¾ cub. yd. bucket, weight about 30 tons, mounted on caterpillars. State maker and give full particulars, also where can be inspected.—Address, P6302, The Engineer Office. P6302 F

WANTED, Modern 40/50-Ton TRUCK WEIGHBRIDGE, in perfect order. State particulars, including maker and age.—Address, 627, The Engineer Office. 627 F

WANTED to PURCHASE, AUTOMATIC KEYWAY CUTTING and VERTICAL MILLING MACHINE; keyseats 24in. by 14in. State price, particulars, and where seen.—Address, P6313, The Engineer Office. P6313 F

ONE CRANE, to Lift 30 Tons, Derrick, Cantilever or luffing type, for steam or electric drive.—Address, P6320, The Engineer Office. P6320 F

PUNCHING and SHEARING MACHINE, to Punch 1in. by 1in., with angle croppers. Send photo and full description.—Address, 613, The Engineer Office. 613 F

AGENCIES

ACTIVE ENGINEER, Connection, Good Offices Westminster, OPEN REPRESENT, commission basis, first-class Constructional Engineers, Ironfounders.—Address, P6336, The Engineer Office. P6336 D

AGENTS REQUIRED in South Wales, Yorkshire, Tyne, Lancashire, to Sell Mechanical Gas Producers and Equipments. Practical knowledge of steel works requirements and good connections essential.—Address, 615, The Engineer Office. 615 D

AGENT REQUIRED in the Southampton District, calling on leading engineers and shipbuilders for sale of pumping machinery and steam fittings.—Address, with full particulars, 621, The Engineer Office. 621 D

EXPORT TRADE.—ENGINEER SALESMAN, Touring India, Straits Settlements, and South Africa, with valuable introductions to public works department officials, municipal, railway, dock engineers, &c., is OPEN to REPRESENT ONE or TWO MANUFACTURERS, Appoint Agents, or Execute other Commissions.—Apply to Box No. 100, McMurtrie's Advertising Agency, 11, Bothwell-street, Glasgow. 625 D

ENGINEER, A.M.I.M.E., with Office and Staff in Manchester, now representing large firm of steam engineers, REQUIRES further AGENCY with first-class Firm of Engineers other than Steam Engines.—Address, P6342, The Engineer Office. P6342 D

EXPERIENCED ENGINEER, A.M.I.C.E., M.I.M.E., DESIRES to ACT as PURCHASING AGENT in London for Manufacturing, Railway Co., or good firm, ABROAD.—Address, P6156, The Engineer Office. P6156 D

FOR SALE

A LEADING LIST

OF NEW and SECOND-HAND MACHINERY can be obtained from W. H. PEASE and CO., Ltd., Hastings House, Norfolk-street, London.

TELEGRAMS: "ENGIPEASE, ESTRAND," LONDON.

SEE OUR ADVERT. ON PAGE 31 OF THIS ISSUE. Ex. G

BORING MILLS.—FOR SALE, 2 Practically New 40in. DUPLEX VERTICAL BORING MILLS, by Webster and Bennett, latest type.—Apply, GEORGE COHEN SONS and CO., 600, Commercial-road, London, E. 14. 605 G

COLD BLAST PIG, N.I. Brand, 25 TONS. Offers for whole or part, f.o.r. South Coast.—Address, P6312, The Engineer Office. P6312 G

DRILLING MACHINES.—We Have in Stock Over 65 DRILLING MACHINES of various types, from 12in. upwards. Prices from £5 to £70. We shall be glad to receive your inquiries.—THOMAS MITCHELL and SONS, Ltd., Edgar-street, Bolton. Telephone 907. Telegrams, "Reality." 480 G

FOR SALE, a 500 K.W., 220-Volt, Shunt-wound D.C. GENERATOR, by B.T.H., complete with switchgear, meters, rheostat, &c., nearly new.—Address, 596, The Engineer Office. 596 G

FOR SALE, Merryweather Valiant STEAM PUMPING SET, 100 galls. per min. capacity, complete, good as new; £75 or near offer.—BENNETT, Middle Farm, Streatley, Dunstable. P6335 G

FOR SALE.—Robey HORIZONTAL DOUBLE-CYLINDER ENGINE, cylinders 12½in. by 16in.; Farrar BOILER, 6ft. by 15ft. 6in.; TWO FEED PUMPS; 10 I.H.P. Anderson HIGH-SPEED ENGINE and PIPING.—Address, 626, The Engineer Office. 626 G

FOR SALE, PUMPING PLANT, Including Crossley 8 Type Suction Gas (convertible to town gas) Engine, 25 B.H.P., in good running order, with Generator and Scrubber complete. Also SET of Excelsior 3-THROW PUMPS, capacity 9000 gals. per hour.

Can be seen running by appointment at Downside Waterworks, Gurney Slade, Bath.

Apply,

DOWNSIDE WATER CO., Ltd.,
Stratton-on-the-Fosse, Bath. P6325 G

FOR SALE.—

ONE PUMPING SET, comprising two-cylinder "Aster" Engine coupled direct to a 6in. Fulcometer Centrifugal Pump; capacity 700 gals. per minute to 50ft. head.

ONE New Electric-driven PUMPING SET, comprising Rees-Roturbo Pressure Chamber Pump coupled direct to 2½ B.P., 440-Volt D.C. Motor; capacity 100 g.p.h. against 150ft. head.

TWO New DITTO, coupled direct to 1½ H.P., 440-Volt D.C. Motor; capacity 1000 g.p.h. against 75ft. head.

141ft. Run of New 15in. CAST IRON DOUBLE-FLANGED PIPE, flanges faced and drilled to B.S.T. No. 2.

432ft. Run of New 6in. DITTO, DITTO, DITTO.

38 New 6in. CAST IRON FLANGED EQUAL TEE PIECES to suit above 6in. pipe.

TWO No. 5 ARBOR PRESSES, by the British Northrop Loom Co.; 10in. clearance from column, adjustable table 19in. by 10in., to admit 24in. high hand lever.

ONE No. 3½ ARBOR PRESS, by the Greenard Arbor Press Co.; rack spindle 2in. dia., leverage 5-1, circular table 11in. dia.

ONE Belt-driven NIBBLING MACHINE, by Burton-Griffiths; admit 36in. in mouth, overhead motion.

ONE New 12½in. Centre LATHE, 10ft. 6in. gap bed, S.A., S.S., and S.C., complete with countershaft.

ONE 36in. VERTICAL DRILLING MACHINE, to drill 12in., automatic and hand feeds, back geared.

ONE 5ft. Double-geared RADIAL DRILLING MACHINE.

STANLEY ENGINEERING CO., Bath. Ex. G

FOR SALE.—

ONE 3-Phase ALTERNATOR, by Lancashire Dynamo Co., 440 volt, 50 K.V.A., 50 cycles, 1000 r.p.m., complete with direct-coupled exciter, switchboard, resistators, and instruments.

ONE Single-phase ALTERNATOR, by Johnson and Phillips, 250 A.C./200 D.C., 9 K.V.A., 50 cycles, 1500 r.p.m., fast and loose pullers and external bearings.

THREE 30in. GRIFFIN MILLS, by Bradley Pulveriser Co.

ONE Small Steam-driven AIR COMPRESSOR.

THAMES METAL CO., Ltd., Northfleet, Kent. P6170 G

FOR SALE, the Largest Stock in the Country of Unused WROUGHT IRON SCREWED and SOCKETTED PIPES, both brand new and ex-Army stocks, as follows:—

11,000 feet, 8" Steam.
100,000 feet, 6" Water.
135,000 feet, 4" Water.
47,000 feet, 3" Water.
12,000 feet, 3" Steam.
40,000 feet, 2" Water.
30,000 feet, 1½" Water.
Also 1", ¾", ½", ⅜".
100,000 feet of 4" Solid-drawn Steel with loose flanges.
5500 feet, 8" Weldless Steel S. and F.
6000 feet, 6" Ditto.

GEORGE COHEN, SONS and CO., 600, Commercial-road, London, E. 14. 586 G

HYDRAULIC PUMPS.—Magnificent SET of Modern Three-throw Motor-driven PUMPS, having 4½in. rams, double helical gearing, 220 volts D.C. motors. Full details.—HARRY R. GARDAM and CO., Limited, Staines. 392 G

For continuation of For Sale Advertisements see page 3.

The Gaseous Fluid Ejector.

By HENRY A. HEPBURN, B.Sc. (Lond.), A.M.I. Mech. E

No. II.*

Induction Drop into Jet.

In practice, with a definite flow of induced mass per second, there must always exist a small pressure difference between the condenser and the jet axis, otherwise flow could not continue. Let P = the condensed pressure, and then $(P - p_3)$ is the flow head. The amount of energy brought up to the jet by the induced mass should therefore be added to the available jet energy. It is usually found that this energy is small in comparison with the jet energy, and may normally be neglected, unless $(P - p_3)$ rises to a significant figure.

If V_c = the volume of a condenser and V_1 is the original specific volume of the contents, then $m_1 = \frac{V_c}{V_1}$ lb. The ejector should be designed to deal with all the leak-in and carried-over air at the pressure p_3 in order that the vacuum may be maintained. Then 1 lb. of the operating fluid performs the work $\frac{W_c^2 - W_v^2}{2g}$ foot-pounds per sec. on the condenser mass, and m_1 gradually falls under constant volume conditions from pressure p_1 to p_3 until the minimum or "critical" mass $\left\{\frac{W_c^2}{W_v^2} - 1\right\}$ is reached per second of flow.

order 0.9 upwards, but of the value of e_c very little is known, except that it is of a small value, probably 0.5 to 0.6 in a diffuser or reversed nozzle compressor as so commonly used for the combining and compressing part of the apparatus. The combined loss coefficient $\left(\frac{1 - e_c e_c}{e_c}\right)$ may therefore be of a very high value, and indeed appears to be so. It may be quite high enough to prevent 1 lb. of the operating fluid from inducing any mass at all, and so the mass of operating fluid must be correspondingly increased, with very poor efficiency results. Every effort must, therefore, be made to decrease the work of compression on whatever curve of compression, the isothermal being the ideal: (*a*) so that W_v may be less, and consequently more mass be induced per 1 lb. of operating fluid as given by the expression (2.2) above; and (*b*) so that with a given compression curve W may be small, on account of the improved mechanical efficiency.

At present, as stated above, the reversed nozzle is in favour, in spite of the experiment of Stodola demonstrating the inefficiency of the method by direct experiment and deduction, when used for elastic fluids. In the combining tube or cone the energies of the combined masses become equalised, it is true, but it is conjectural as to what really occurs. One thing is definite, and that is that condensation of the steam jet must be prevented, but at the same time it is advisable to condense out as much of the vapour from the condenser as possible, and also cool the leak-in air from the same source, so that the compression work may be immediately reduced. These two opposites may be reconciled in practice if the jet if m falls below its critical value outside air can expand into the annular space round the jet. This should not be wasteful of energy, for if correctly designed the air leak mass can expand down from p_1 to p_2 and bring up its own compression energy less losses. In any case it is cheaper to do this than to open up the steam jet inflow valve. The air leaks would appear to be necessary because the cross-sectional areas of the diffuser cannot be correct for all states of flow, and it is not a good combination to use adjustable nozzles without adjustable diffusers. It has been found that good design may eliminate air leak devices.

Boiler Feed Injector.

It will now be clear that the correct compression work is of the utmost importance for economical running. This has been evident for years in the case of the boiler feed injector. Consider Fig. 1 *ante*, where H C can represent the steam expansion line from the boiler pressure; then, owing to the losses, the steam cannot compress itself back to H along the reversed expansion line. It must partially or wholly condense. If it all condenses into the induced feed water, the energy $\frac{W_c^2}{2g}$ will not be available on account of continuous condensation preventing any re-expansion after mingling, such as occurs with elastic fluids; but it may be stated that the energy P R H C can be used for giving momentum to the feed water. If the temperature of the feed water rises, the water line P R moves away from the pressure axis to $P^1 R^1$, where $(1 - x)$ lb. of water compresses up P R and x lb. steam up $P^1 R^1$. The induced water will also go up

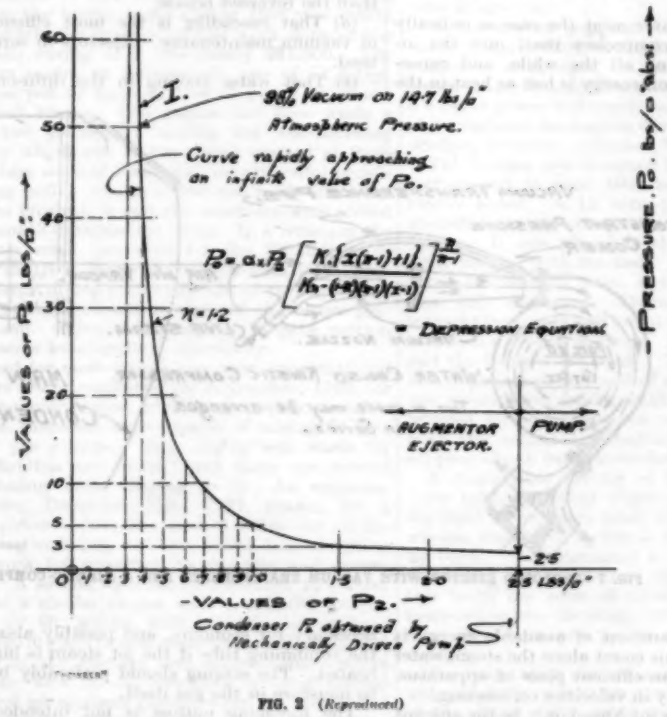


FIG. 2 (*Reproduced*)

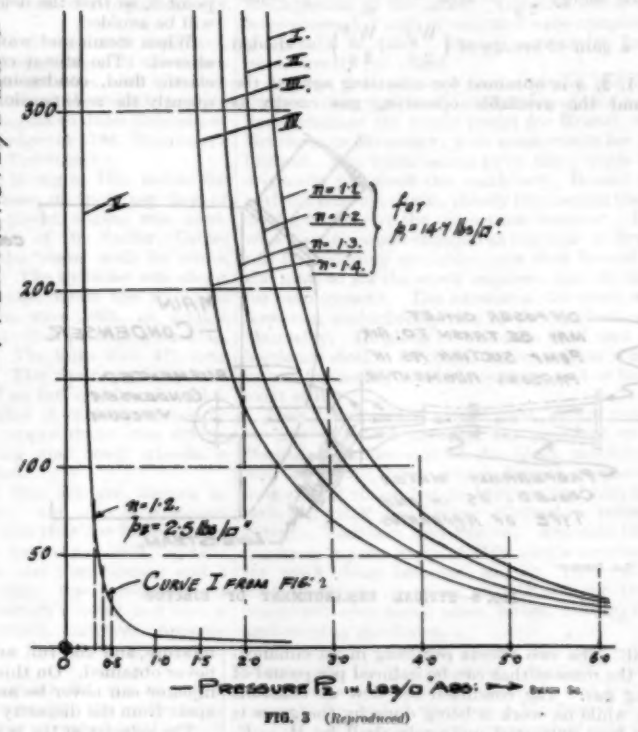


FIG. 3 (*Reproduced*)

The work done on the mass m_1

$$= \frac{V_c}{V_1}\left\{(p_1 - p_2)V_2 - \frac{n}{n-1}p_2 v_2\left\{1 - \left(\frac{p_1}{p_2}\right)^{\frac{n-1}{n}}\right\} \times e_c\right\} \text{ foot-pounds}$$

$$= V_v\left(\frac{p_1}{p_2}\right)^{\frac{1}{n}}\left\{(p_1 - p_2) - \frac{n}{n-1}p_2\left\{1 - \left(\frac{p_1}{p_2}\right)^{\frac{n-1}{n}}\right\} \times e_c\right\} \text{ foot-pounds}$$

and is equal to $\frac{W_c^2 - W_v^2}{2g} \times$ Time of Action to produce the vacuum pressure, referred to unit mass per sec. of operating fluid.

Effect of Losses.

Again, from equation (1.25) *ante*—

$$E_c = \left(\frac{1}{e_c} - e_c\right)\frac{n}{n-1}(p_1 v_1 - p_2 v_2)$$

for the range from p_1 to p_2 which is to be supplied by the operating gas.

Therefore A_e = available energy for inducing gas is

$$= \frac{n}{n-1}(p_2 v_2 - p_1 v_1) - \left(\frac{n}{n-1}\right) \times (p_1 v_1 - p_2 v_2)\left(\frac{1 - e_c e_c}{e_c}\right) \quad \ldots (3)$$

Now, e_c, the nozzle efficiency, is known to be of the steam be highly superheated at the end of expansion and the combining tube be slightly water cooled remotely from the nozzle exit area. It is open to question whether the vapour will give up heat quicker to the walls than receive it from the impinging jet steam. The principle appears to work satisfactorily in a well-known type of air jet extractor. It should be remembered that in dealing with elastic gases the energy loss does not depend upon the squares of the velocities, but upon the square of the relative velocities, so that if the vapour and air can be gradually brought up to the steam jet in a series of cones, the efficiency can be greatly improved, as pointed out many years ago by Perry. The time factor is an important one in compression, on account of the radial in-and-out flow, and it is this radial flow that really determines the correct angles and lengths of the two cones that make up the complete diffuser; but, as is very usual in practice, an empirical determination is the best for lengths and times.

The next advance to be made is in more correct compression so as to avoid the present losses. This may possibly be achieved by a kinetic compressor of the type in which a forced vortical motion is impressed upon the gases while compression and water cooling takes place.*

The value of m in expression (2.2) is the "maximum" or "critical" mass at the pressure p_2 with a fixed annular area of inflow. If the amount of inflow air mixture should fall below the designed amount there is the serious effect of a blow back into the condenser. This can be avoided by the provision of automatically controlled air leaks, arranged so that the line P R, x being the dryness fraction of the jet steam. If the feed water temperature rises still further the sum of the steam compression work plus the losses is too great for the available energy and the action of the injector ceases. Cold water jacketing of all combining nozzles and diffusers is, therefore, a most desirable feature, and especially so in condenser augmenting systems, and has been successfully adopted in this country.

Cooling Before Compression.

Now, consider what effect is produced when the operating fluid final temperature is different from that of the induced fluid, and when the combined stream is cooled before and during compression. Referring to Fig. 5, let $\overline{0, 5, 6}$ represent the operating expansion line, $\overline{1, 2}$ the induced fluid line, and $\overline{3, 4}$ the compression curve, and the point 7 the $p\,v$ state of the combined streams at the pressure p_2. It is assumed that cooling may take place at constant pressure p_2 down to the point 3. The line $\overline{3, 4}$ is preferably an isothermal and the others, by the nature of the conditions, are adiabatics. Let T_3, T_7, T_2, and T_5 be the absolute temperatures at the suffix points and suppose that the kinetic energies at those points are $\frac{W_6^2}{2g}$, $\frac{W_7^2}{2g}$, &c.

Then area $\overline{5, 9, 6} = \frac{W_6^2}{2g}$ − area $\overline{11, 5, 6, 10}$ is the work that produces the vacuum pressure p_2 by ejecting the original mass in the condenser. The critical mass m will flow into the annular jet area with a velocity = say, W_7. Suppose that the streams combine with

* No. I. appeared October 20th.

* This apparatus was described briefly in the April, 1922, number of *Stats Technology*.

a loss coefficient of r, such that $r\left(\frac{W_6^2}{2g} + m\frac{W_2^2}{2g}\right) = (1+m)\frac{W_7^2}{2g}$. The mean temperature will be T_7.

$$T_7 \text{ approximately} = \frac{T_6 + m T_2 + \frac{(1-r)}{J C_p}\left(\frac{W_6^2 + m W_2^2}{2g}\right)}{(m+1)}$$

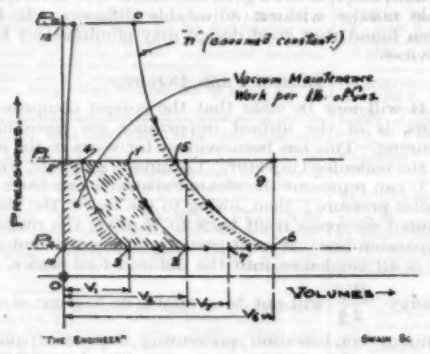


FIG. 5

The stream is then cooled along the p_2 line to the temperature T_2 and the compression work thereby reduced from $\frac{W_7^2}{2g}$ to $\frac{W_2^2}{2g}$ foot-pounds per pound, where the energy $\frac{W_2^2}{2g}$ = area $\frac{11, 4, 3, 10}{e_c}$; consequently a gain of energy of $\left(\frac{W_7^2}{2g} - \frac{W_2^2}{2g}\right)$ = shaded area 4, 1, 2, 3 is obtained for offsetting against the losses and the available operating gas energy is increased. The two effects resulting in an enhancement of the mass m that can be induced per pound of operating gas. The condition for flow at constant pressure while no work is being done by the gases is that the heat extracted uniformly shall be $H_c = C_p(T_7 - T_2)$ per pound, and it is possible to arrange the areas of flow at 7 and 3 that constant velocity conditions hold good.

Now, assuming that it is possible to transfer the vacuum effect from the point 6 to the point 3, a new conception of m arises. Assume that all the curves are adiabatics and that the energy at the point 5 is

$$\frac{W_5^2}{2g} = \frac{n}{n+1}(p_0 v_0 - p_1 v_1) \times e_c.$$

Then—

$$(m+1) = \frac{W_6^2}{W_2^2} \ldots \text{and } W_6^2 = \text{area } \overline{11, 5, 6, 10} + \frac{W_2^2}{2g} = \frac{W_x^2}{2g} + \frac{W_2^2}{2g};$$

but $\frac{T_2}{T_6} \times \frac{W_x^2}{2g} = \frac{W_2^2}{2g}$ by assumption.

$$\text{Then } (m+1) = \frac{W_6^2 + W_x^2}{W_x^2 \times \frac{T_2}{T_6}} = \left(\frac{W_6^2}{W_x^2} + 1\right)\frac{T_6}{T_2} \quad . \quad (4)$$

giving m in terms of the steam jet energy and the final expansion and cooled temperatures; m has an enhanced value per 1 lb. of operating gas or steam in the ratio of $\frac{T_6}{T_2}$ over the value when no cooling is adopted for the assumed conditions. For a given ratio of $\frac{W_6}{W_x}$, the more the final temperature is lowered by vigorous water or other cooling the more economical the process, since the mass of the operating fluid can be reduced for a given performance. Again, it can be shown that the ratio $\frac{W_6}{W_x}$ increases as p_2 diminishes, so that the most economical apparatus is that which produces the highest possible vacuum with the greatest amount of cooling that can be adopted. It would appear better, on these hypotheses, to use only live steam for the ejection nozzle.

If the mass m be fixed, as in practice, equation (4) may be transformed to

$$m_0 = \frac{m}{\frac{T_6}{T_2}\left(\frac{W_6^2}{W_x^2} + 1\right) - 1} \quad . \quad . \quad (4.1)$$

where m_0 = the mass flow per second of operating fluid, a value which diminishes with increasing $\frac{T_6}{T_2}$ and $\frac{W_6}{W_x}$.

$$\frac{W_6^2}{2g} = \frac{n}{n-1}(p_0 v_0 - p_1 v_1) \times e_c = C_p(T_0 - T_3) \times e_c \times J$$

$$\frac{W_x^2}{2g} = \frac{n}{n-1}(p_1 v_1 - p_2 v_2) \times e_c^1 = C_p(T_0 - T_6) \times e_c^1 \times J.$$

where n has the same assumed invariable value.

It does not appear to be useful to formulate conditions for the mingling of the gases, but the combining nozzle should presuppose a compression of the gases with subsequent re-expansion, for by those means only can the shock and loss heat be recovered in the form of increased velocity when mixing is complete. Such heat as is not usefully recovered will be removed by cooling down to the $p\,v\,t$ state at the point 3, so that the deleterious effect in compression will be avoided.

When steam and water meet the case is radically altered. The steam compresses itself into the inelastic fluid, condensing all the while, and consequently the re-expansion energy is lost as heat in the mixture, and the full amount of available energy is never obtained. On this count alone the steam water injector can never be an efficient piece of apparatus, apart from the disparity in velocities on meeting.

The velocity at the point 3 need only be the amount required to maintain a pressure head of $(p_1 - p_2)$, but it is obvious that by increasing W_2 that the combined stream may have a velocity at 3 sufficient to carry it up to a higher pressure than p_1. The ejector then passes into the category of an injector, and the mass m becomes greater than that given by 4 in the ratio of $\frac{W_2^1}{W_2}$, where W_2^1 is the enhanced velocity through the fixed area over which the operating fluid maintains the depression effect. By varying T_2 the energy of $\frac{W_2^2}{2g}$ may carry the combined stream to any desired pressure, but the compression requires to be carried out in a much more efficient piece of apparatus than at present, however alluring it may be in its simplicity.

Variation of Initial Jet Pressure.

Equation (1.6) enables the determination of the effect of a variation of either p_0 or p_2 on the remaining one.

An example will show the method more clearly.

Suppose that $n = 1.2$, $p_1 = 14.7$ lb. per square inch, $a = 1.1$, $k = 0.9$. Let p_2 be 2.5 lb. per square inch and vary p_2 by $\pm$ 2½ per cent.

Case I.—Then

$$p_0 = a \times 2.5\left[\frac{.9\ \{5.88\,(1.2-1)+1\}}{.9 \times 1.2 - 0.1 \times .2 \times 4.88}\right]^6$$

= 176 lb. per square inch for a gaseous ejector.

Case II.—Now vary p_2 by + 2½ per cent. and calculate p_0.

p_0^1 = 158 lb. per square inch.

$\therefore$ the percentage variation in $p_0 = \frac{176 - 158}{176} = 10$ per cent., so that varying the initial steam or gas pressure by ± 10 per cent. produces a variation in vacuum pressure of approximately 2½ per cent., the vacuum, therefore, not being sensitive to changes in p_0 when p_2 is very low.

Series or Cascade Effect.

Now, suppose that a piston extractor produces a vacuum pressure of 2.5 lb. per square inch, and that the vacuum is required to be depressed to 0.5 lb. per square inch absolute. By inserting the value of $p_2 = 0.5$ and $p_1 = 2.5$ in equation (1.6) gives $p_0 = 19$ lb. per square inch absolute, so that exhaust steam could be used for the cascade effect; but, in view of possible cooling being adopted, it would be more economical to use a less amount of live steam and get a still lower vacuum p_2. The piston extractor, it must be remembered, should deal with the outflow from the ejector after it has been raised in pressure in the diffuser, but if live steam is used this course would not be necessary. Curve V. in Fig. 3 is Curve I. from Fig. 2 drawn to the same scale as Curves I. to IV., and demonstrates clearly the effect of lowering p_1 artificially from 14.7 lb. per square inch to 2.5 lb. per square inch. Fig. 6 shows a typical arrangement of ejector which is self-explanatory. Fig. 7 shows a proposal with vacuum transference, constant pressure cooling, and a kinetic compressor. It is considered to be the more economical arrangement.

In conclusion, it appears that:—

(*a*) Given a value of p_0, there is only one value of p_1 for a given p_2.

(*b*) Superheating the ejector nozzle steam is highly desirable.

(*c*) That a more efficient compressor is required than the reversed nozzle.

(*d*) That cascading is the most efficient method of vacuum maintenance. Ejectors in series may be used.

(*e*) That water cooling in the diffuser is vitally necessary for economy, and possibly also cooling of the combining tube if the jet steam is highly superheated. The cooling should preferably be that due to moisture in the gas itself.

The foregoing outline is not intended to be a rigorous demonstration of the various flow phenomena. Such an analysis is almost impossible, but it is thought that the theory put forward may be of some practical use in explaining the reason of some hitherto obscured points. The weak point of the ejector is not the nozzle action nor the combining action, but the compressing apparatus, and particular care must be given to the improvement of that part.

The depression theory is common to both gas and steam jet ejectors, and may be used for a determination of the vacuum pressure obtainable in one stage, or for the number of stages required for a given vacuum pressure.

The mass flow theory is similar in principle for both types, but modifications are introduced for the pure air-vapour ejector on account of the condensation effects on cooling. These require a separate discussion because the vapour mass varies from point to point, especially on mingling with the steam jet.

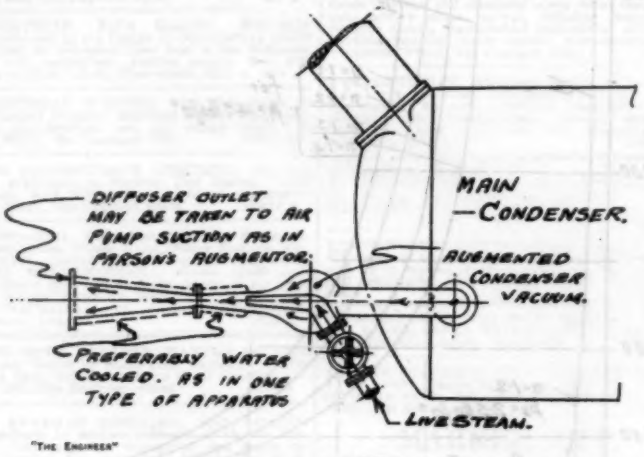

DIFFUSER OUTLET MAY BE TAKEN TO AIR PUMP SUCTION AS IN PARSON'S AUGMENTOR.
MAIN —CONDENSER.
AUGMENTED CONDENSER VACUUM.
PREFERABLY WATER COOLED. AS IN ONE TYPE OF APPARATUS
LIVE STEAM.
"The Engineer"

FIG. 6—TYPICAL ARRANGEMENT OF EJECTOR

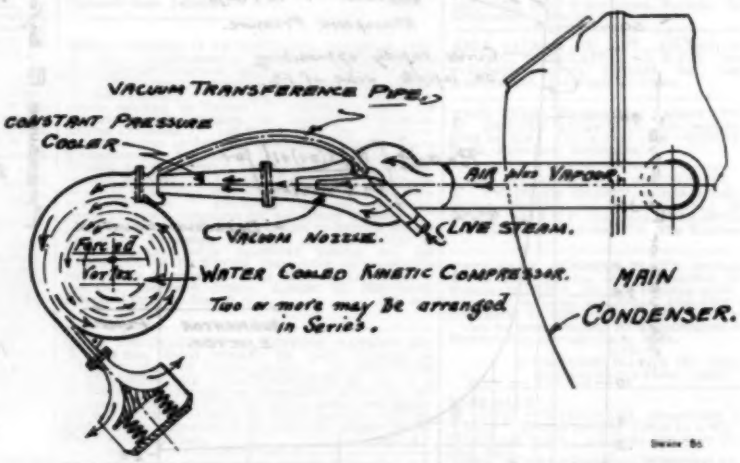


FIG. 7—PROPOSED EJECTOR WITH VACUUM TRANSFERENCE AND A KINETIC COMPRESSOR

Speaking at the official opening of the new Cowlyd Lake dam, Carnarvonshire, Mr. Henry J. Jack said that a dream rose in his mind. His dream was this: He saw the harnessing of the whole of the water-power resources of North Wales, and the combining with them of all those reservoirs which were already established, and upon which to a great extent money had been wasted, because they were not fully used, and the running from one central point of a great pipe that would come down and supply London, if it wanted it, and be available for every town on its way. He saw that pipe carried from the south to the north of the British Islands, so that the Scottish water would flow down it, and the country would be assured of a water supply under pressure without exorbitant cost!

Simon Goodrich and His Work as an Engineer. Pt. I., 1796-1805.*

Compiled from his Journals and Memoranda by E. A. FORWARD, A.R.C.Sc., M.I. Mech. E.

SIMON GOODRICH was a Government official, whose name is now unknown to the world in general, but who appears to have been well known to contemporary engineers. He was born on October 28th, 1773, his father, Isaac Goodrich, being, it is believed, a Suffolk man. During the greater part of Sir Samuel Bentham's period of office as Inspector-General of Naval Works, Goodrich was his chief assistant, and he carried into effect the various engineering schemes prepared by Bentham for the dockyards. After that time he had the management of the engineering works in the dockyards and was consulted by the Navy Board on all such matters which were submitted to them.

His position thus brought Goodrich into contact with most of the well-known engineers of the day, and numerous letters from such are amongst his papers. He kept a daily journal and memorandum book, but this is not uniformly complete over the whole period covered, which extends from 1802 to 1845. These books contain interesting references, often with sketches, relating to the engineering works of all kinds which came under his notice, and from these a selection has been made.

Perhaps the principal achievements of Bentham were the introduction of steam engines, against great opposition, into the dockyards, and the setting up of the wood mills, metal mills and millwrights' shop in Portsmouth Dockyard, for the more economical manufacture of naval requirements. The success of these establishments is indicated by the facts that the savings on the blocks made during 1808 was nearly £17,000, while the savings on the work done in the metal mills during 1812 was nearly £11,000. The first steam engine at Portsmouth, one of 12 horse-power, was put up early in 1799 to pump water out of the dock basins. This engine had been made a year or two earlier for driving the woodworking machinery which was to have been erected at Redbridge, where some of Bentham's experimental vessels were being built; but as it was not ready until the ships were finished, it and the machines were stored at Portsmouth until needed there. In a return of the mechanist's work, prepared for the Committee of Revision in 1806, Goodrich records that the engine drove a large lifting pump capable of raising 7 tons of water per minute, and it replaced the horses previously used. When not pumping, it gave motion to Bentham's woodworking machinery.

The need for more power was soon apparent, and plans were under consideration in October, 1799, for a 30 horse-power engine, which was to work six chain pumps 2ft. diameter, each capable of raising 10 tons of water per minute. This engine was made by Messrs. Boulton and Watt,† and there are several letters, during 1800, relating to it. An estimate, dated Soho, December 12th, 1799, quotes, for a 30 horse-power engine, the sum of £1050 for all the metal work, including one iron boiler, but excepting the ironwork for screwing the framing and cistern together. A second estimate of February 5th, 1800, quotes for a similar engine with a cylinder 28.5in. diameter by 6ft. stroke, with a crank motion fixed to it, for £1070 plus the cost of carriage to Portsmouth. Drawings of the framing and engine-house—which are shown—were to be furnished without further charge, and an engineer provided for the erection of the engine, whose wages were to be charged at 30s. per week. Delivery could be given in three or four months and payment was to be made on receipt of the materials.

A letter written by Gregory Watt, on April 26th, 1800, gives a list of prices of rotative engines of different sizes which is of interest. It is as follows:—

	£
4-horse engine, including one iron boiler..	327
10 ditto	491
20 ditto	750
30 ditto	1050
40 ditto	1440
50 ditto	1727

The smaller engines could be delivered in three months and the larger in between three and four months from order.

A letter from John Southern, dated April 29th, 1800, says that Boulton and Watt had no experience of burning cinders and little of burning wood—as was stipulated at the Dockyard—but suggested a grate area of 36 square feet instead of 22 square feet as for coal. The engine was under construction in June and the parts were sent to Bristol for conveyance to Portsmouth in September, 1800. This engine differed somewhat in its arrangement from the standard Watt engine of a slightly earlier date. It still retained the wooden beam, which was 26in. deep and 18in. thick, but the A frame had disappeared and a massive oak transverse beam 28in. by 20in., supported by the side walls, carried the beam gudgeons and spring beams. The cylinder was supported on a brick pier instead of being mounted on wooden beams spanning the condenser cistern.

The chain pumps and gearing were made by John Lloyd, millwright, of Little Chapel-street, Westminster. A description of the pump drawings, with instructions to the maker, exists and is dated April 22nd, 1800. A curious point about these pumps was that they were intended to reverse and work as prime movers by the action of the water running out of the docks. One gear wheel of each pair had wooden mortice teeth, while some of the wheels fitted closely on round parts of the shafting so that they could be moved laterally to disengage them. These were secured by a "tongue and groove" and were pinned to the shaft when in position. This is an early instance of wheels being keyed on round shafts. A copy of the bill for these pumps, dated December 31st, 1800, shows that their manufacture and erection cost £1761 4s. 7d.

About this time Goodrich mentions the making of a model of a machine for experimenting on the comparative strength of different metals, woods, and filamentous substances.

In September, 1800, Goodrich was at Brixham, surveying the ground for the laying of 2000ft. of 8in. cast iron pipe to convey fresh water. An inquiry, sent to Mr. Littlewood, of Park Furnace, Sheffield, elicited the reply that the latter was busy casting 17in. pipes for the New River Company and could do no other work for eight weeks. The price of 8in. pipe was 13s. 6d. per cwt.

At about the same date some particulars are given of Bentham's floating dam or caisson for a dock gate, which was proposed in 1798 and made in 1799, with the method of operating it. It was built of timber and weighed 157 tons, the ballast amounting to 171 tons. It was noted that, whereas the North Dock gate required sixty men to open it and the South Dock gate ninety men, the floating dam only required forty men to move it.

A noteworthy proposal of Sir Samuel Bentham, made in April, 1800, was the application of the steam engine to a dredger. Although this was the first steam ladder dredger, Boulton and Watt had supplied a 4 horse-power bell-crank engine to John Grimshaw, of Sunderland, for a spoon dredger in 1796. Bentham's dredger, however, preceded Trevithick's.

The dredger was designed to dig to 16ft. below the surface and to raise 1000 tons of spoil per day of twelve hours. A 12 horse-power engine was used, modelled exactly on the lines of the Sadler (Table) engine. It was placed in the vessel with its crank shaft parallel with the keel. The cylinder was about 20in. diameter by 48in. stroke, while the fly-wheel was 14ft. diameter. There were 96ft. of double wrought iron chain and twenty-four plate iron buckets, of which a sketch is given. The links were 4ft. long and the buckets 4ft. wide. The chain passed round drums placed at each end of an inclined frame, which was mounted in guides so that it could be raised or lowered by a winch; the upper drum was driven from the engine by shafting and bevel wheels, a slipping clutch being provided.

A remarkable feature of this dredger, known as "the ballast heaving engine," and also of a second one built a few years later, was that the boiler had a wooden shell built up like a cistern and held together by bolts. This contained a cast iron furnace and a convoluted wrought iron plate flue. Sketches of this boiler are given in Goodrich's notes and also a more complete drawing, which, however, appears from its dimensions to be a boiler for the second dredger.

The boiler shell was rectangular, 9ft. 4in. long, 6ft. wide, and 6ft. 4in. high internally, the walls being of 4in. plank. The grate was arranged transversely near one end, with the fire-door on one of the longer sides. The flue was 18in. square in section. Some time afterwards a new furnace and flue were fitted with the fire-door at one end and the grate running lengthwise. The dredger was ready for trial in April, 1802, and was under test for some months.

The success of the first dredger being assured, Bentham proposed in July, 1803, to make a second one for use at Deptford. He also proposed to fit this with a Trevithick high-pressure engine, and it is recorded in "The Life of Trevithick" that Bentham, in August, 1803, ordered a 14 horse-power engine for Deptford Dockyard. The Greenwich explosion of a Trevithick boiler in that year prevented this project from being carried out, so that the second vessel was actually fitted with a duplicate of the Sadler type of engine used in the first.

In September, 1801, Bentham proposed to construct a "moveable steam engine" which could be used for working cranes, pumping or pile driving wherever occasion arose for its services; it was finished in August, 1802. This, however, was not the first design for a portable engine, as the Coalbrookdale sketch book contains drawings, dated 1792, of a condensing beam engine mounted on a wheeled carriage, but it is not known whether this was actually constructed.

In Bentham's machine a 6 horse-power double-acting condensing steam engine was used, having a cylinder 13½in. diameter by 36in. stroke, with drop valves. It was a table engine with roller crosshead and guides set transversely.

The first boiler used with this engine was a wooden barrel, but this was replaced in March, 1805, by a rectangular wooden box, as shown on the drawing exhibited. It was mounted on a separate wooden carriage, 11ft. 9½in. long and 4ft. 9in. wide; its hind wheels were 5ft. 1in. diameter and the four wheels were 3ft. 0½in. diameter. Both carriages had shafts for horse haulage.

* Early in 1802 it appears that the managers of the London Company for the Manufacture of Flour, &c., were considering the rebuilding of the Albion Mills, which, as is well known, had been burned down in 1791. A premium of fifty guineas was offered for the best plans submitted for a fireproof building, and in February of that year Goodrich sent in plans which enabled him to share the premium with another competitor.

Although the story of the block-making machinery at Portsmouth is comparatively well known, this paper would not be complete without some reference to it, as Goodrich's notes contain many references to this work and give some new information relative to it.

Sir Samuel Bentham had intended from the first to erect such machinery in Portsmouth Dockyard, and he had patented machinery for the purpose in 1793, while some of the preliminary machines had been made before 1800.

Sir Marc Isambard Brunel had considered the problem of block-making machines before he left the United States in 1799, and on February 10th, 1801, he took out a patent for improved machines for this purpose. Brunel's plans were offered to Taylor and rejected by him, but when submitted to the Admiralty in February, 1802, they were adopted on Bentham's recommendation, and Maudslay was entrusted with the construction of the machines, under Brunel's superintendence. Brunel was specifically instructed to concert with Goodrich in the arrangement of the machines in the wood mills, which were under the management of the latter. The first set of machines were proceeded with at once and were completed about the middle of 1803. Brunel appears to have been paid directly for these.

A great deal of discussion arose in the middle of the last century as to the authorship of this machinery. Some claimed the whole credit for Brunel, others for Bentham or Maudslay, with some credit for Goodrich himself. The truth seems to be that, while Bentham originally proposed the machinery, Brunel appeared with his improvements, chiefly for shaping the outsides of the blocks, at the opportune moment. Bentham, who was too much engaged at the time to devote himself to designing machines, saw that Brunel was just the man to do the work required, and recommended his employment. The success of the machinery was, however, undoubtedly due to the mechanical skill of Maudslay. In place of wood he used cast iron and hardened steel in its construction, so that it continued in use for nearly a whole century and is believed to exist still.

The "Journals" record that about every three months Goodrich certified the payment of £500 to Maudslay on account of the block machinery. He also seems to have found Brunel somewhat of a nuisance at times, but in 1805 we find him congratulating himself on having effected a reconciliation between Bentham and Brunel. Amongst Goodrich's papers is a press copy of Maudslay's account, which, for work done between August, 1803, and April, 1807, amounts to close on £12,000 for thirty-nine machines, comprising saws, lathes, boring, morticing and shaping machines.

Maudslay's lathe for turning iron pins is deserving of mention. In this lathe the "poppitt" alone slides along the vee bed, while the slide rest travels on a separate flat bed at the front. The feed is stopped by dropping the worm out of engagement with its wheel. The form of tool holder, in which a small cutter is clamped in the end of a stiff bar, should also be noted. This arrangement was used on many of the machines and is shown in Brunel's patent of 1801. A large part of the machinery was driven by flat belts tightened by jockey pulleys, while in other cases friction wheels were used.

Under date September, 1802, Goodrich gives some figures for determining the power of a horse, taken from one used at the Sheerness well; these give the work done as 8000 foot-pounds per minute. He was in the habit of making notes and sketches of ideas that occurred to him from time to time, and some of these are interesting, although there is no evidence that they were put into practice at the time. On a foolscap sheet, watermarked 1803, but upon which he had subsequently written "about 1800," there are sketches which might represent a steam-driven helicopter. On the same sheet are several designs for steam boilers, one being a horizontal multitubular fire-tube boiler, and another a similar boiler with a single convoluted flue of small diameter.

Mention must here be made of the very important note, made almost certainly in 1803, and obtained from Trevithick himself. This gives the only known contemporary illustration of part of Trevithick's London coach engine of 1803, but as it is described in Vol. I. of the Society's "Transactions" no more need be said of it here. Then in February and March, 1804, we have the interesting letters from Samuel Homfray, of Penydarran, dealing with the first trial of Trevithick's tramway locomotive and the reason for putting off Goodrich's visit to see the further trials.

Under date August 16th, 1804, is given a comparative list of prices of steam engines by three makers, which is of interest:—

* The Newcomen Society. The author exhibited many original drawings.

† The drawings are preserved in the Boulton and Watt College.

Messrs. Boulton and Watt.

	£
20 horse-power	1083
24 horse-power	1276
30 horse-power	1418

Including all the metal work and an iron beam, but not erecting or woodwork.

Mr. Trevithick.

	Guineas.
1 horse-power	120
2 horse-power	210
3 horse-power	270
4 horse-power	330
5 horse-power	380
6 horse-power	420
7 horse-power	450
8 horse-power	470

And 20 guineas for each horse-power above this.

Including patent right and fixing, but no brickwork.

Fenton, Murray and Wood.

	£
20 horse-power	600
25 horse-power	715
30 horse-power	830
35 horse-power	938
40 horse-power	1045

Not including boiler.

It will be noticed that Boulton and Watt prices had increased by some 40 per cent. since 1800.

The practice of sheathing the bottoms of ships had been in use for many years, when about 1790 complaints were made about the rapid decay of some of the copper sheets. As the complaints increased the opinion was formed that the contractors were supplying inferior copper than formerly, and Bentham proposed in April, 1800, that, as a first step towards improving it, a mill for re-manufacturing the old copper should be set up in one of the dockyards. It was not, however, until September, 1805, that the mill was completed, and the rolling of sheathing commenced.

The whole of the machinery for the metal mills, including rolls, hammers, and steam engine, was executed by Mr. Whitmore, of Birmingham, but he did not make a very satisfactory job of it. The steam engine, of 56 horse-power, was a beam engine of the Watt type, with a cylinder 38in. diameter by 7ft. stroke. A blowing cylinder 30in. diameter and 3ft. 8in. stroke was placed between the crank and the centre pillars. The cost of the metal mills engine and machinery was £6000, and some of the chief items in Whitmore's bill may be noted. The engine itself cost £1700, while a premium of fifty guineas was paid to fit Roberton's patent feeding mouth to the boiler for consuming smoke and saving fuel. Other items are :—

	£	s.	d.
A pair of rolls, turned, 70 cwt.	74	5	9
The main shaft, 72 cwt.	61	12	6
Fly-wheel, 12.2 tons	98	12	6
Blowing cylinder and fittings	128	19	8
Two pairs of plain rolls with housings, &c., 15 tons	423	18	2
Ironwork for tilt hammers	80	15	0
Three anvil blocks, 8 tons	113	8	0
Three beds for ditto, 6¼ tons	87	10	0
Two pairs grooved rolls	138	6	0
A pair of shears with wheel in the lever and excentric cam wheel (on a new construction equal in value to two pairs), weight 2¼ tons	59	14	6
A boiler fitted up complete, 6 tons 17 cwt.	274	14	0
Carriage of materials	195	15	5

Little information is available about the furnaces, save a few sketches, but two refining furnaces and two heating furnaces are mentioned, besides a "cupula," of which a drawing is shown.

Difficulty was experienced in obtaining suitable workmen for the metal mills, and they were accused of seducing men from the contractors' works by the offer of double wages. If that were really the case, then the said contractors must have paid very low wages indeed, as the copper melter in the dockyard received £2 per week plus 6s. for house rent, for which he was to make one charge of 2 tons per day. His assistant received 27s. per week. The normal day was twelve hours, including meal-times, the men in the metal mills commencing work at 5 a.m. The superintendent of the mills received £4 per week. A gallon of small beer per day was allowed to the men at the furnaces and rolls, although Goodrich says he would have liked to do away with this and give money instead.

While these mills were under construction Goodrich visited various works throughout the country and he gives particulars of what he saw in them.

Goodrich gives some particulars of Benyon's flax mill at Leeds, which he says was on the same plan as Marshall's, they having parted partnership. The mill had arched floors built between cast iron girders, which were supported on cast iron pillars placed about 10ft. apart. Power was obtained from a 50 horse-power engine put up by Fenton and Co. He notes that the machinery was driven from horizontal shafts 4½in. square, making 60 revolutions per minute. The lengths of shafting had pyramidical ends, coupled by boxes in halves, so that the shafts could not draw out; 6in. or 8in. straps were tightened upon the driving drums by two tightening rollers close to the drums.

One or two more of Goodrich's "Ideas" of about this time may be mentioned. One of these was that a mechanical museum should be established in London, showing nothing but working models of the most common and useful machines. Lectures were to be given and 2s. 6d. charged for admission, this price to include admission to the museum. The machines to be minutely described in a catalogue, which was to be *lent* to the visitors.

Another idea was for land "Scaites," of which he gives a sketch showing each skate with two wheels of perhaps 8in. diameter.

An idea which he thought might be a good subject for a patent was for the application of an easily renewable piece of leather, wood, cork or any tough and elastic substance to the soles and heels of boots and shoes. In this he was about a century too soon. Perhaps his most curious idea was for a contrivance by which a horse drawing in a mill or otherwise should bring into action an automatic goad, so that if he did not pull with a certain force it should prick him until he did.

In July, 1805, Sir Samuel Bentham received orders to proceed to Russia, to arrange for the building there of ships for the British Navy, and Goodrich was appointed to carry on the work of the Inspector-General's office during his absence.

There we must leave Goodrich for the present, but the writer hopes to continue his story in a future paper.

Marseilles-Rhone Canal.

The port of Marseilles is being extended to the barrier formed by the Nerthe range, through which a tunnel has been driven nearly 4¼ miles long and 72ft. wide—the largest of its kind—for the passage of a canal to the Etang de Berre, and thence along the Etang de Caronte to Port de Bouc, where it will join the canal to Arles, a total distance of 50 miles. The scheme, which is illustrated in the accompanying illustrations and those on pages 433 and 442, is one of the most imposing yet put in hand. It means that Marseilles will embrace the large lagoon known as the Etang de Berre, in which there is practically unlimited anchorage for large cargo boats, and will be in direct communication with the Rhone at Arles and, consequently, with nearly the whole of France and Central Europe, as soon as the Rhone hydraulic scheme is completed. Nearly the whole of this work is being carried out by the Marseilles Chamber of Commerce, which has arranged its plans with the anticipation which is regarded as being a certainty,

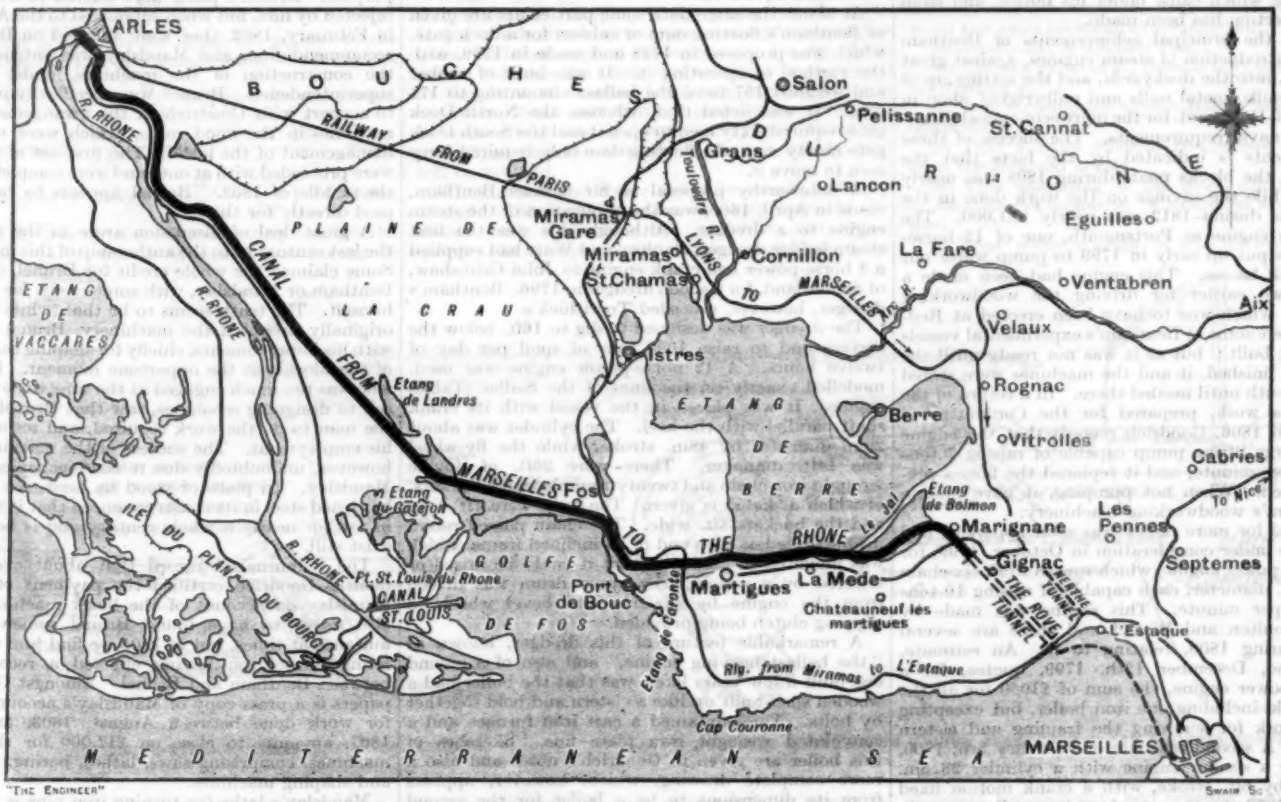


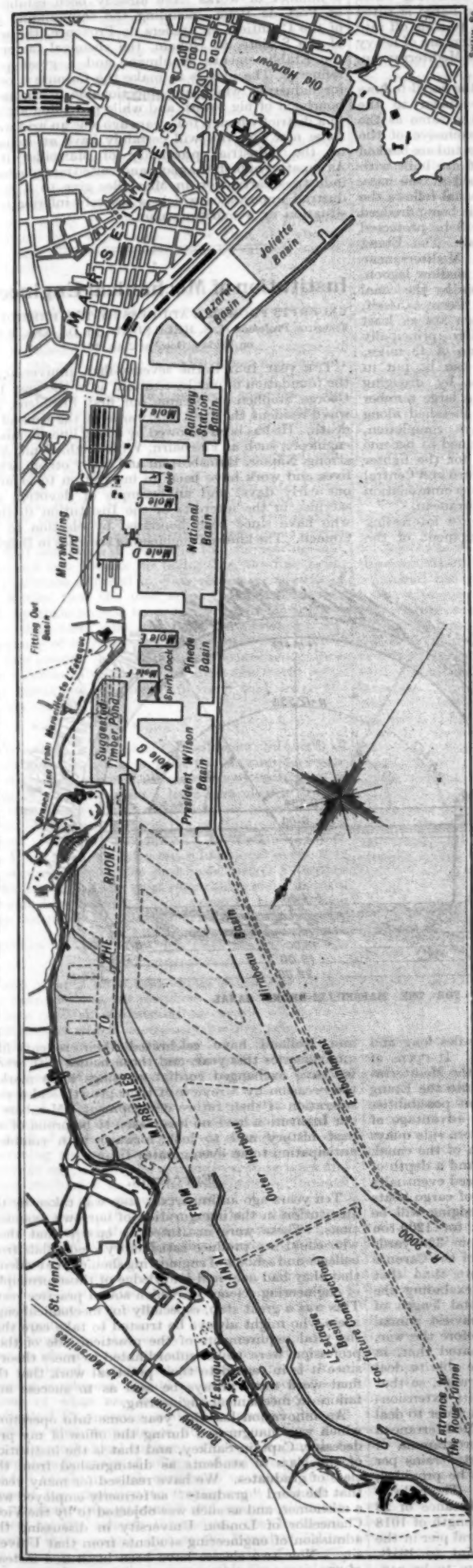
FIG. 1—PLAN SHOWING THE ROUTE OF THE CANAL BETWEEN MARSEILLES AND THE RHONE AT ARLES

The port of Marseilles is being extended to the barrier formed by the Nerthe range, through which a tunnel has been driven nearly 4¼ miles long and 72ft. wide—the largest of its kind—for the passage of a canal to the Etang de Berre, and thence along the Etang de Caronte to Port de Bouc, where it will join the canal to Arles, a total distance of 50 miles. The scheme, which is illustrated in the accompanying illustrations and those on pages 433 and 442, is one of the most imposing yet put in hand. It means that Marseilles will embrace the large lagoon known as the Etang de Berre, in which there is practically unlimited anchorage for large cargo boats, and will be in direct communication with the Rhone at Arles and, consequently, with nearly the whole of France and Central Europe, as soon as the Rhone hydraulic scheme is completed. Nearly the whole of this work is being carried out by the Marseilles Chamber of Commerce, which has arranged its plans with the anticipation which is regarded as being a certainty, that within a few years the port will be providing accommodation for double the present tonnage. The only drawback is that the work is not proceeding so rapidly as could be desired on account of the difficulty of procuring funds in the present state of the country's finances.

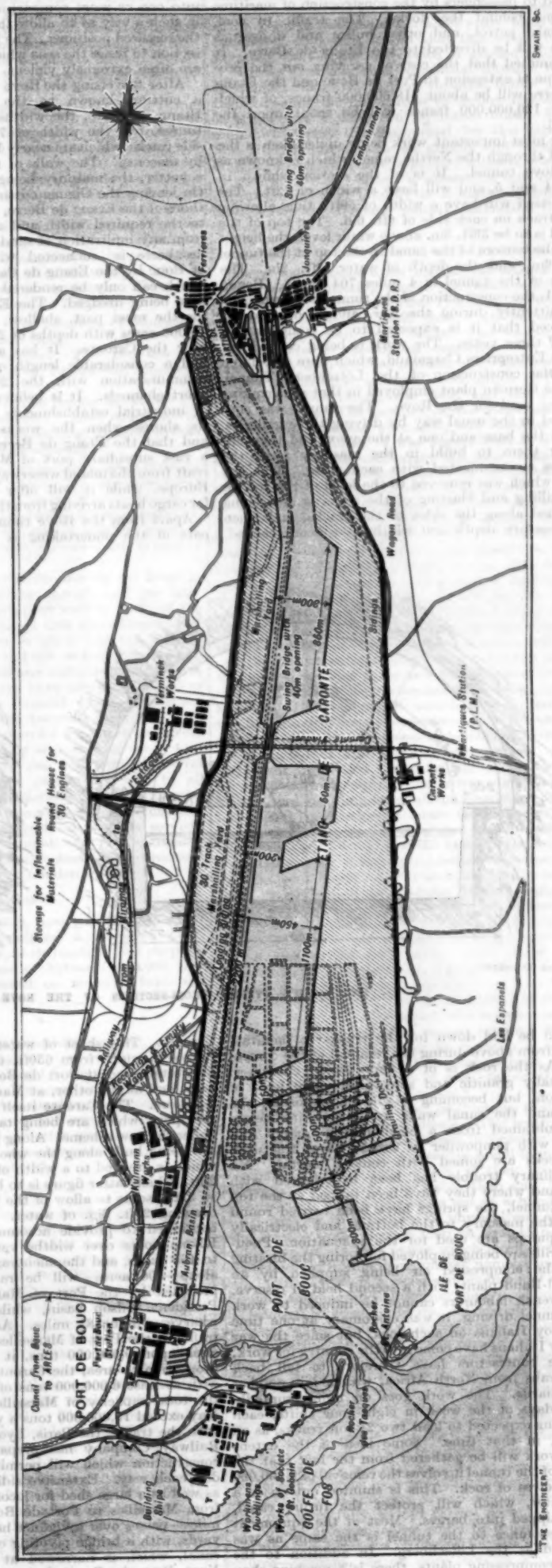
In addition to the old port—to the extreme right in Fig. 2, page 433—Marseilles has seven basins connecting with one another, the last to be virtually completed being the President Wilson, which has a depth of 39ft. The area available for the accommodation of shipping is 435 acres, and the total length of wharves is nearly 12 miles The programme of future extensions includes the construction of the expansive Mirabeau basin, which will be a continuation of the President Wilson, and then the basin of L'Estaque, which will complete the series of docks to the point at which the canal enters the tunnel passes through the Nerthe range. The canal itself will pass behind the docks as far as the President Wilson basin, with a passage into the "Avant port" between the Mirabeau and Estaque basins. These extensions have been rendered necessary not only by the congestion of traffic in the old docks, but also by the large tonnage which it is expected will develop with the opening of the Rhone to navigation.

Marseilles has not yet regained her pre-war activity, for while in 1913 the total tonnage of goods loaded and unloaded by steamships was 8,192,765 tons, it fell in 1921 to 5,520,863 tons, of which British ships carried 1,289,740 tons, or more than one-half the total dealt with by the French vessels, which have a monopoly of the North African trade. The tonnage handled at Marseilles has at times been inferior to that of Rouen, which owes its occasional

THE MARSEILLES-RHONE CANAL



PLAN SHOWING THE PORT OF MARSEILLES AND ENTRANCE TO THE CANAL



THE WORKS IN THE ETANG DE CARONTE

superiority to imports of British coal, and in carrying out its programme, Marseilles aims at reserving the existing docks for general merchandise and for passenger traffic. Greater conveniences are to be offered to passengers by the construction of maritime stations behind the docks. The traffic in coal, minerals, petrol, and other bulky and dangerous goods will be diverted to the Etang de Berre. It is estimated that the cost of carrying out the programme of extension to Port de Bouc and the Etang de Berre will be about 318,600,000 francs, of which about 120,000,000 francs will be spent upon the tunnel.

The most important work being undertaken is the tunnel through the Nerthe range, which is known as the Rove tunnel. It is of the section shown in Figs. 4 and 5, and will have a width of 72ft. The canal itself will have a width of 59ft., thus allowing for a track on each side of 6ft. 6in. The top of the tunnel is to be 36ft. 3in. above water level, the height from the bottom of the canal to the top of the tunnel 50ft. 6in., and the depth of water 13ft. 2in. The length of the tunnel is 4 miles 704 yards. Begun in 1911, the construction of the tunnel was continued intermittently during the war, and is now so far advanced that it is expected to be completed in two or three years. The work is being carried out by the Entreprises Chagniaud, which were associated with the construction of the Lötschberg Tunnel, and the German plant employed in that undertaking is being used for the Rove. The tunnel was constructed in the usual way by driving three galleries, two at the base and one at the apex, and then enlarging them to build in the masonry until the galleries communicated with each other. This left a core which was removed to the level of the tracks. The drilling and blasting of the rocks is now being continued along the sides of the tracks, and when the necessary depth and width have been reached, special barges with flush decks and built with longitudinal and lateral water-tight bulkheads. The concrete blocks, weighing 50 tons, are loaded on to the barge by a floating crane, and by admitting water into one or more compartments, the barge is tilted in such a way as to allow the blocks to slide off into the required positions. The breakwaters are of heavy section to resist the seas which, in the Mediterranean, are often extremely violent.

After traversing the Rove tunnel, the canal follows a cutting—known as the Gignac—down to the Etang de Berre, the widths being the same as the tunnel, but the width of 75ft. is exclusive of the side tracks, which are nearly 10ft. wide and are banked by masonry. The walls of the canal are built with a batter, the masonry being thickened at the base. On leaving the Gignac cutting, the canal follows the shore of the Etang de Berre, and while being dredged to the required width and depth, will be protected from any infiltration of sand by a wall. The Etang de berre is connected with the Mediterranean at Bouc by the Etang de Caronte, a shallow lagoon, which can only be rendered navigable by the canal now being dredged. The Etang de Berre is itself, for the most part, shallow, but there are at least 15,000 acres with depths of 26ft. to 30ft., principally near the Caronte. It has a coastline of 43 miles, and a considerable length of shore can be put in communication with the 30ft. area by dredging short channels. It is believed that a large number of industrial establishments will be installed along its shores when the works approach completion, and that the Etang de Berre is destined to become a vast subsidiary port of Marseilles for the lighter craft from the inland waterways of France and Central Europe, while it will offer ample accommodation for cargo boats arriving from the Mediterranean.

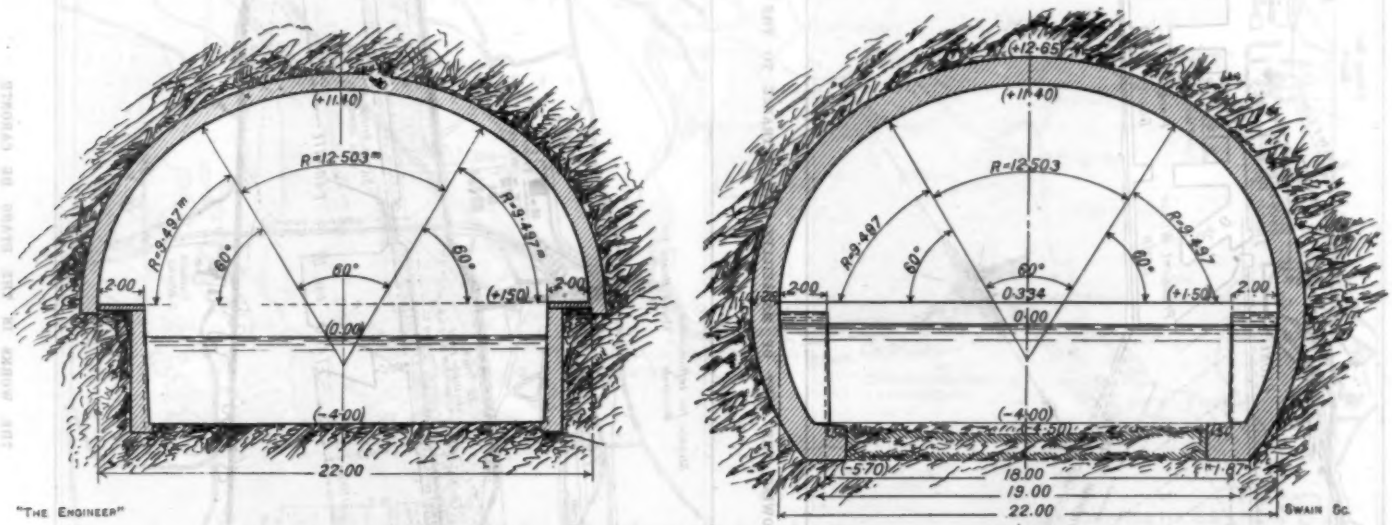
Apart from the Rove tunnel the most interesting part of the undertaking is the equipment of the varies from 2ft. to 23ft. above the sea level, there is a lock.

In view of the carrying out of this undertaking, a number of works have already been established at Port de Bouc, including the shipbuilding yard of the Chantiers et Ateliers de Provence, the works of the Société St. Gobain, the chemical factory of the Etablissements Kuhlmann and a great petrol refinery. The idea is to make the Caronte a centre for industries which are objectionable in the neighbourhood of big towns, and while providing activity to a district which a few years ago was an arid waste, these new factories will certainly have an influence on the industrial prosperity of Marseilles itself. As a matter of fact, the many and varied manufacturing industries carried on in Marseilles give to it an industrial importance which is scarcely inferior to its situation as a maritime port.

Institution of Mechanical Engineers.

EXCERPTS FROM THE ADDRESS BY THE PRESIDENT, Emeritus Professor H. S. HELE-SHAW, LL.D., D.Sc., F.R.S., on Friday, October 20th, 1922.

The year 1922 is the seventy-fifth anniversary of the foundation of our Institution, as in the year 1847 George Stephenson became our first President, and was President the year afterwards at the time of his death. He has been followed by a long line of eminent engineers, such as Fairbairn, Whitworth, Penn, Armstrong, Napier, Ramsbottom and many others, whose lives and work have been an inspiration to us all in our early days, and an example of devotion and sacrifice in the interests of the Institution to those who have since been honoured by election to the Council. The kindred engineering societies in Belgium



FIGS. 4 AND 5—TYPICAL CROSS-SECTIONS OF THE ROVE TUNNEL FOR THE MARSEILLES-RHONE CANAL

rails will be laid down for the trucks to facilitate loading from above during the removal of the central core. As the rock is of a very varied character, occasionally granitic and sometimes very hard of extraction, but becoming friable on exposure, the tracks and the canal walls are lined with heavy blocks obtained from a neighbouring quarry and blasted with gunpowder to avoid risk of fractures. The blocks are joined with cement mortar. No extraordinary trouble has been experienced with water, and where they have been tapped at the top of the tunnel, the springs have been carried round behind the masonry to the bottom, and electrically driven pumps are used for the evacuation Pneumatic drills are being employed for boring the blasting holes, the compressed air being supplied by an Ingersoll-Rand plant, with a second held in reserve.

As French labourers cannot be induced to work upon tunnel driving, it was customary at one time to employ Italians on such jobs, but since the war very few Italians have come into the country for work, and the contractors have therefore to fall back upon Arabs from North Africa, with a fair number of Spaniards. The work goes on uninterruptedly for six days of the week in eight-hour shifts, each man being expected to load two 2½-ton trucks, as an average, in that time. Some idea of the extent of the work will be gathered from the fact that the driving of the tunnel involves the removal of 2,500,000 cubic metres of rock. This is shunted out on to a breakwater, which will protect the future canal, and is tipped into barges. Most of the equipment at the entrance to the tunnel is the same as was employed at the Lötschberg. In addition to the two air-compressing plants, there is a machine shop and a carpenter's shop for effecting repairs to the rolling stock and material. The first section of the breakwater has been completed, and most of the other sections for protecting the canal have their foundations of concrete blocks. These are loaded on to Caronte. This sheet of water is 3¾ miles long and ranges in width from 650ft. to 3000ft. It opens at its western end at Port de Bouc into the Mediterranean, and at the other, at Martigues, into the Etang de Berre. The Caronte itself has great possibilities as a port, which are being taken full advantage of under the new scheme. Along its northern side quays are being built along the whole length of the canal, which is dredged to a width of 393ft. and a depth of 26ft., which latter figure is to be increased eventually to 33ft., so as to allow of the passage of cargo boats drawing 29ft. 6in. of water. The dredging will be continued to provide accommodation for 1200-ton Rhone boats over widths varying from 328 yards to 465 yards, and the anchorage area of the Caronte alone—500 acres—will be rather more than that provided by the Port of Marseilles, excluding the President Wilson basin, while the total length of wharves will be 8½ miles. As the heaviest annual traffic in the Port of Marseilles was, before the war, close upon 9,000,000 tons, it is estimated that, in proportion to area, the Caronte will be able to deal with at least 6,000,000 tons of merchandise, so that the total capacity of Marseilles with its extensions may exceed 15,000,000 tons a year. In order to deal with the traffic, the Paris, Lyons and Mediterranean Railway Company has prepared a programme of construction which will permit of thirty trains per day each way. Extensive sidings will be provided, as well as a large shed for locomotives. The railway from Marseilles to Port de Bouc—a distance of 28 miles—passes over a viaduct having a length of 1018 yards, with a bridge pivoting on a central pier in the canal, which is narrowed at this point to 131ft. Near Port de Bouc various docks are to be constructed, and in the port itself the canal joins the existing canal to Arles, where it is in communication with the Rhone. As the canal is on the sea level, there are no locks the whole way from Arles to Marseilles. At Arles, where the level of the Rhone and Holland have celebrated their seventy-fifth anniversaries this year, and those bodies with whom we have exchanged cordial greetings have marked the occasion by a review of their growth and a consideration of their future development. Members of our Institution have no less reason to be proud of our past history and to look forward with confident anticipation to an even greater future.

Education.

Ten years ago an important step was taken by the Institution in the inauguration of our own examinations. These were instituted to ensure that those who could not produce satisfactory credentials from colleges and schools of engineering should give evidence that they had acquired knowledge of those principles of engineering science on which sound practice rests. This was a great step, especially for mechanical engineers who might always be trusted to take care that the vital requirements of the practical side of their profession were never subordinated to mere theory, since it is in regard to their practical work that the final word must always be said as to success and failure in mechanical engineering.

An innovation has this year come into operation, which was inaugurated during the office of my predecessor, Captain Sankey, and that is the institution of the class of students as distinguished from the class of graduates. We have realised for many years that the word "graduate" as formerly employed was a misnomer, and as such was objected to by the Vice-Chancellor of London University in discussing the admission of engineering students from that University. Now two classes have been instituted instead of one.

A student class has been formed, in which class all those who have adopted mechanical engineering as a profession are allowed to enter between the ages of sixteen and twenty-five. Before being recognised as a student, they must have either passed what was

previously called the examination for graduates or be able to present equivalent certificates of University matriculation standard. The name "graduate" is still retained, but is now employed in its correct sense, and indicates not merely those who have qualified by a University degree, or by passing our own examination for corporate membership, but have already proceeded to an extent satisfactory to the Council in their practical training at engineering works. In other words, they must have given proof that while they have attained a standard in engineering science previously demanded of associate members, they are getting practical experience fitting them in due time to be raised to the class of corporate membership. This is entirely in accordance with the spirit of most of my able predecessors in their views on education, and enables the Council to consider the advancement of graduates to the rank of associate members solely on the grounds of their practical knowledge and experience. Now that the change is understood, it is appreciated by all classes of membership.

Recognition of Professional Status of Members of our Institution by other Authorities.

The high standard of the scientific as well as practical knowledge of our members is now recognised all over the world, and it is realised that membership of our Institution has become a coveted distinction to be earnestly sought and jealously guarded. One of the most remarkable results of this is the change of attitude of official bodies generally, and especially of Government and the military Services, this being enhanced no doubt by the general change of conditions since the war.

To take the fighting branches, the Air Force, Transport, Royal Army Service Corps, Tank Corps, all these departments have approached the Institution through their departmental chiefs for co-operation and assistance in regard to the engineering side. There are two reasons for doing this, the first being the guarantee afforded in each respective branch of the Service that the men employed in engineering work by them should be properly qualified, and the other that men who are being prepared for the emergency of war may, by admission to the Institution and passing its examinations, secure recognition from mechanical engineers all over the world as to their status and acquirements when they leave the military service.

* * * * * *

After all, the real test of the influence and power of a body like our own is to be felt in its complete control of the education of all members of its branch of the profession, and what I have said already proves that through the ranks of mechanical engineers and in the Government Services the position we have now secured is felt and recognised. In further proof of this, I will now deal with one educational event that has occurred during the past year, which I venture to think is one of the most remarkable steps forward that our Institution has ever taken in the direction of the control of the education of mechanical engineers.

National Certificates and Diplomas in Mechanical Engineering.

From what I have said about recognition of our own examinations, all members will realise that we are in a position of insisting on certain educational qualifications which necessarily involve preparation in order to produce evidence for this. But the event of the year which I have just alluded to is the action of the Board of Education in putting us in a position to share with it in the control of the education—not merely of a large number of those who become members of the Institution, but of those engaged in the work of mechanical engineering attending the day or evening classes of technical colleges or schools—that is to say, all pupils, apprentices, improvers and skilled mechanics as well as draughtsmen, foremen and managers of engineering works.

The initiative in this matter came from the Technological Branch of the Board of Education, and the feeling of the Council is that this action of the Board of Education and of its able servants shows what a great step the official world has taken in calling to its aid in work of that kind those who have hitherto been excluded from the magical circle of Government Departments.

It is important that every mechanical engineer at home or abroad, who has any influence with young men employed by him or the responsible task of selecting employees, should grasp the essential conditions of what are now National Certificates in Mechanical Engineering, and when grasped give full weight to their importance, for it is our hope that no young mechanical engineer, who may be unable to secure the advantage of college and university degrees will fail to obtain such certificate or regard it as a passport for admission to employment. Whilst all the certificates are presented and examinations conducted by the schools themselves, the Institution appoints the assessors, just as the Board of Education appoints the inspectors, and to the Institution such assessors are entirely responsible for considering all papers, reviewing and supervising all results. All such results are submitted to the Joint Committee of our Council and the Board of Education, all doubtful cases on the border line being specially considered.

In this way it is believed that the Institution and the Board of Education will most effectively control the education of mechanical engineers throughout the country. Our initiative action has been followed by other Institutions for their own special subjects.

A National Certificate will, it is hoped, be one of the greatest assets that a young man who has finished his apprenticeship can present in seeking employment, and the form of the certificate is such that it can always be presented by an engineer in search of a job.

Local Branches.

Probably next in importance to the progress of education and technical requirements comes the advance which has been made so that the various centres of engineering industry should as far as possible have equal advantages with the London members in regard to meetings and discussions. The first steps towards this were taken in 1914, by the appointment of honorary local correspondents to arrange for meetings and discussion in the provinces. It was, however, not until after the war—in 1921—that local branches were inaugurated. These at present number four, and are as follows:—

Midland Branch: The counties of Warwick, Stafford, Worcester and Salop.

North-Western Branch: The counties of Lancaster, Chester, Derby, Carnarvon, Anglesey, Denbigh and Flint.

Yorkshire Branch: The county of York.

South Wales Branch: The counties of Cardigan, Radnor, Pembroke, Carmarthen, Brecknock, Glamorgan and Monmouth.

It is expected that branches covering other districts will be formed in the near future. It is very gratifying to note the enthusiasm and success of these branches, two of which have already started Graduates' Sections, and the programme for the winter session, given in the last issue of the *Journal*, indicates the extent of these activities.

Council has also evinced its anxiety to keep in touch with members residing abroad, and has established Advisory Committees in various parts of the British Empire. It is thought that these Committees will keep distant members in touch with the Institution and with each other, and will be useful in bringing to the notice of the Council any matters affecting their interests. The Committees have also been found of great assistance to the Council when considering applications for joining the Institution.

Another step forward taken for the first time during the past year is the holding of examinations in provincial centres. They are also now held at several places abroad. The same papers are sent to all centres and opened simultaneously, and the Council is indebted to those local Committees and members of the Institution who have freely given their services and arranged for these examinations to be conducted, thereby saving the younger members the expense and loss of time in travelling to London.

Research.

In the year 1879—that is, nearly fifty years ago—the Institution first appointed a Research Committee, and devoted some of its funds to this purpose, and since then the sum of between £13,000 and £14,000 has been expended on research from the Institution funds.

* * * * * *

The general feeling of members appears, at any rate, to be very clear that in view of the growth of various other Institutions and Societies dealing with special branches of applied science since our research work began, our Institution should not encroach upon the ground which the newer and special Institutions are from their membership better qualified to undertake, but which in early days there was no other body than our own able to deal with.

Finance.

The Institution building was erected in 1898, and with the Princes-street extension, which was completed in 1913, has cost the total sum of £100,793. The property is held under leases from the Ecclesiastical Commissioners and Dr. Williams' Trustees, the principal lease expiring in 1974. In 1917, the Council—at the suggestion of Mr. Mark Robinson, then chairman of the Finance Committee, to whom the Institution will for ever be under a deep debt of gratitude—instituted a Leaseholds Amortisation Sinking Fund by setting aside the sum of £20,000 in 5 per cent. war stock, and it was estimated that this sum, with all accrued interest, would realise about £202,000 at the end of 1973. The incidence of the war has, however, so completely changed the aspect of housing, rating and finance, that it seems advisable to consider the question of enfranchisement—that is to say, purchase of our freehold. Otherwise when our lease ends the whole of our splendid building, with all improvements and additions, will have to be handed over to our landlords, and we may be turned into the street with only our books, furniture and models. The Ecclesiastical Commissioners are not prepared to sell any of their property, but we are advised they would entertain a proposal to extend our lease for 999 years at, however, a very considerably increased ground rent. Dr. Williams' Trustees cannot move without the consent of the Charity Commissioners, and it is unlikely that they would view sales from any other standpoint than that taken by the Ecclesiastical Commissioners. Any improvement or extension carried out by the Institution to the building or its amenities would enhance the value of the messuage in the event of the freehold or a 999 years' lease being obtainable, and it is feared that this would reflect adversely on the purchase price or ground rent. It is hoped, however, that legislation already before Parliament may be carried through before many years to enable the Institution to become freeholders of their own building on equitable lines. Funds should, therefore, be earmarked for this purpose. The able architect who so greatly improved our building in recent years is going—without charge—to present to the Council a scheme of still further improvements, and notably in a matter which has been before the Council, namely, alteration in our lecture hall.

Scientific Knowledge and Invention.

There was a time when mechanical science with mechanical engineering was in comparative infancy. Not so very long ago our former President, Sir William Fairbairn, stated, in 1859, that when he entered London forty-seven years before—that was in 1812—there were *no mechanical engineers*. In those days a man with little education, but what has been called "mechanical instinct," had ample scope for invention. Everything was new, and the ground was untrodden. The locomotive, the steamboat and the stationary engine were new, and machine tools were few and simple. I was apprenticed as a millwright, and the old millwright did everything from putting the wooden teeth made of hornbeam into the cog wheel, setting the valve of an engine—a work of great mystery—chipping out the keyway, or making a pattern, and, of course, always forging, grinding and setting his own tools. The early engineer had to invent everything he wanted or used, but although that is all changed to-day, invention is just as vital to progress in mechanical engineering as it was in those old days, say, seventy-five years ago. Indeed, the stress of competition necessitates the more intense application of the inventive faculty, and an average of 30,000 patents is taken out each year by inventors searching for new devices and in the hope of securing some new results. Inasmuch as anything that has been patented within the previous fifty years—beyond which search is not conducted by the Patent Office—is considered as anticipated, it is easy to see what a hopeless task is being attempted by the ignorant and uneducated inventor. I say "ignorant" and also "uneducated," for in one case he is probably attempting to discover something well known, and spending often all his means and that of his friends in producing some familiar and well-known appliance, and in the other case he lacks the education which would prevent him from attempting the hopeless task of trying to produce the impossible. Anyone who studies the *Patent Journal* week by week must see that even to-day the attempts of a large number of inventors would be ludicrous if they were not in most cases pathetic. Over and over again the form of rotary engine, which for more than half a century has been well known to be quite inefficient, is produced and reproduced in various forms with all its original defects.

Futile inventions may be divided into two classes, the first being those in which the inventor seeks a result which is no use when he has attained it; the second class is that in which an inventor is seeking the impossible—in fact, is following an *ignis fatuus*. Let me give some examples of each, taking them in each case from the *Patent Journal*.†

It is, of course, such absurd productions that bring invention in general into ridicule. The truth, however, must be told that engineers in practice in the the course of their work constantly spend large sums of money on inventions which, if they are more plausible, are not less impossible than any I have collected. In ninety-nine cases out of a hundred, a sound training in principles of physical and mechanical science would keep a man on sound lines and enable him to use that power which most of all distinguishes him from a mere animal, namely, imagination. James Watt is a wonderful example of a man of sound training and education applying himself to the solution of great problems, not merely the great problems which resulted in a separate condenser, but his wonderful mechanisms for parallel motion. I have long thought, that beyond general engineering training, the time had come for an actual Chair of Invention, and in a speech I was asked to make at the Watt Anniversary at Birmingham I ventured to suggest the idea—as likely to produce the best results—of a Chair of Invention to perpetuate the memory of James Watt in Birmingham. I still hope to see such a Chair founded somewhere, and although an eminent man and practical engineer, who was receiving the honorary degree at the time spoke quite disrespectfully to me of my proposal, I am sure he and other engineers could be brought to see the value of a Professor of Invention who would give lectures—perhaps one or more lectures a year—to

† The President then gave eight examples of such patents, with the drawings as reproduced by the Patent Office, some illustrating absurd objects to be attained, and some illustrating proposed contrivances altogether violating well-known mechanical laws.

engineering students of different schools throughout the country, in which he could place before rising engineers a number of principles on which success depends, the method of obtaining information on what had already been achieved in any subject, the cause of failure in previous attempts, and how to approach new problems so as to avoid falling into endless repetitions of previous workers. I know from my own experience of the hundreds if not thousands of ideas brought by students of ingenious minds that a very large number of such students could be put in the right path, and saved from disheartening and futile mistakes.

The very first clause in the objects of our Institution is stated: "To promote the science and practice of mechanical engineering, to give impulse to inventions likely to be useful to the members of the Institution and to the community at large." I emphasise "likely to be useful" because this object of the Institution is just as important as any of the others, and I still hope to see the subject of invention treated in the same scientific manner, as clearly one of the most important of our objects. In concluding this portion of the subject I want to say something about our patent laws.

Whatever impulse in the way I have suggested, or in any other way, our Institution may be able to give to invention, it must not be overlooked that by far the greatest inducement to invent is the protection afforded by the Patent Office. A patent is granted, not as some people think, because the Government has the slightest interest in that individual inventor, but simply and solely in the interests of the public, so that by the inducement of the reward in the form of a monopoly for a certain number of years the public may in return reap the fruit both of the genius of an inventor and of the expenditure of money by the capitalist necessary to produce and bring to fruition a successful invention.

From time to time the patent laws have been modified and improved, and our Institution has always been ready to take its part for the protection of the inventor, at any rate in engineering matters. Only recently—1918—when an attempt was made to introduce undesirable modifications in the patent law, a strong representative Committee was formed of different Institutions, and our own President at the time—Mr. Longridge—took the chair at the meetings on the subject, with the result that the most objectionable features were removed. The alterations contained one clause of the greatest value, namely, the increase of duration of a patent from fourteen years to sixteen, thus bringing the time nearly to that of the American patent, which is granted for seventeen years. Even now the American patent has the great advantage that it is dated from the time of sealing, often a year or two or even more after the date of application, whereas the British patent dates from the time of application. I can go back far enough to remember other changes of great importance, noticeably that introduced at the time when Joseph Chamberlain was President of the Board of Trade, by which anyone is now able to purchase for £1, at a post office, an application form for provisional protection, and send in this form by post. There are certain other matters in which our Institution might use its influence suggested to me by a friend of experience. One of these concerns the revocation of a patent, another designed to effect a clear understanding of the relation between employer and employee in matters of invention, another the rights of the Controller of Patents in regard to the power of refusing a patent for something which, although it may be new is not, in his opinion, an actual invention, and, lastly, the introduction of something sorely needed between a patent and a design, as provided for by German patent law.

Finally, to take a matter of great importance. To-day, when there is so little opportunity in mechanical engineering directions of far-reaching discovery and consequently of a master patent, a cheaper patent for a short time—say, a period of five or six years—ought to be granted for an improvement which may be of great value, although the matter may be a comparatively small one. For this, a small fee might be charged—say, £1 a year—enabling the inventor to introduce small improvements for which he would not receive adequate protection by registration of design, but which would be at once copied. Thus, after great expense in the way of experimenting, devising and making patterns, he finds a week or two afterwards that his actual device has been copied—even put on the market; even, perhaps, been actually used with a trivial alteration as a pattern to mould from. Engineers will appreciate the discouragement to progress which the absence of some sort of protection produces in cases of this kind.

I trust that not merely will the Institution continue as it has done to aid in improvement in patent laws, but that active steps will be taken in this and kindred patent matters in the spirit and letter of our articles, so as to "give impulse to invention."

Conclusion.

Amongst many subjects of interest and importance is the relation of kindred Institutions to ourselves. Following the words of Joshua Field, which I have already quoted, are these: "Our two societies embrace the whole science, and by combining their efforts with mutual goodwill and a perfect understanding, they may and do confer great benefits on the public." This was nearly seventy-five years ago, and shows the splendid spirit in which the birth of our Institution was welcomed by the premier engineering Institution of Civil Engineers. I rejoice to say that not only have those feelings of friendship and goodwill, so happily expressed, always existed, but we are proud to think that we have ourselves likewise extended the same welcome to new engineering institutions as they have arisen. At the present time there is a Committee of the four leading Institutions—Civil, Mechanical, Electrical and Naval Architects—engaged in considering how we can draw still closer together and ultimately embrace in harmonious relationship all the junior institutions. I will not anticipate the labours of that Committee, and speculate how far they will co-ordinate all engineering examinations, or what they will achieve. There is one thing I may remark, that just as Civil Engineers freely lend their building to other Institutions, and did so to ourselves in our infancy, so we claim to have followed their good example, and, apart from bare expenses, lighting, &c., have allowed the use of our building for meetings and conferences. Our home is, however, in some respects, too small for our needs. The pressure of numbers has made it impossible to hold an annual *soirée* under our own roof. In America the great Institutions are happily united in one large building. I venture to express a hope that, if possible, the Civils and ourselves may approach so closely that by means of subways beneath or bridges above we may possibly unite our buildings so that on great occasions each Institution may have the benefit of the united structures for social gatherings. This might lead, as in America, to the libraries of both professions being available for members of both, but at any rate whatever the details may be, one thing is certain, that especially now that engineering is being recognised as a learned profession, all members of it should have a tangible bond of union for mutual benefit.

Lloyd's Register—Annual Report.

The annual report of Lloyd's Register of Shipping for the year ended June 30th, 1922, has just been issued. It is too long a document to reproduce in full, or, indeed, to give anything like a full abstract of it. We must, therefore, content ourselves with the following general review. It is pointed out to begin with that, although at the time of writing the report there were in some directions signs which might be indicative of a possible recovery in the shipbuilding industry, it would take much more than was at that time on the horizon to enable builders to have any confident expectation of refilling the berths which are left vacant by the completion of tonnage now in hand; and that with the world outlook as it was, it would seem that the only consideration which would dispose shipowners to make themselves responsible for outlay on new tonnage, except as regards passenger liners and vessels intended for special trades, would be the knowledge that there will be a sharp demand for the most up-to-date types as soon as the upward movement of freights begins, in order to meet the severe competition which must then arise.

The total of new tonnage to which classes were assigned by the Committee of Lloyd's Register during the year ended June 30th, 1922, amounted to 623 vessels, of 2,523,992 tons gross, a reduction of 22 per cent. on the figures for the preceding twelve months. This tonnage, however, was well in excess of the highest figure recorded—in 1913-14—in pre-war years. The Society's returns show, further, that at the end of June last 464 vessels, of 2,010,912 tons gross, were being built throughout the world under the Special Survey of Lloyd's Register, with a view to classification in the Society's Register Book, but included in that total were 526,592 tons upon which work was suspended for one reason or another. The number of plans for new vessels passed by the Society during the year inevitably reflects the prevailing conditions. The figures comprise only 138 vessels, of 230,920 tons, and are the lowest recorded for more than thirty-five years. The countries in which the majority of the 623 vessels classed by Lloyd's Register during the year were built were the United Kingdom, with 406 vessels, of 1,536,423 gross tons; the United States of America, with 45 vessels, of 286,539 gross tons; Holland, with 44 vessels, of 159,184 gross tons; Japan, with 26 vessels, of 152,524 gross tons.

The total tonnage of merchant vessels afloat at the end of June, 1922, holding the classification of Lloyd's Register exceeded 27,000,000 tons, and was the highest figure ever recorded. The number of vessels concerned was 10,029. To these figures should be added 296 vessels, of 1,524,013 tons, which appear in the Register Book with the notation "Class Contemplated." A large number of these were completed and classed during the printing of the Register Book, while the construction of the remainder has been far advanced. The aggregate of shipping coming under the ægis of Lloyd's Register's classification therefore comprises 10,325 vessels, of more than 28½ million tons gross.

Included among the vessels built during the year which received the Society's classification were 32, exceeding 10,000 tons each, as compared with only 10 falling within this category during the previous twelve months. Of these 32 vessels, 23 are between 10,000 and 15,000 tons, while the following 9 each exceed the latter measurement, viz.:—Giulio Cesare, 21,848 gross tons; Empress of Canada, 21,517 gross tons; Scythia, 19,730 gross tons; Laconia, 19,680 gross tons; Samaria, 19,602 gross tons; Conte Rosso, 18,017 gross tons; Montcalm, 16,418 gross tons; Montrose, 16,402 gross tons; and Tyrrhenia, 16,243 gross tons.

Steam turbines were installed in 98 vessels, of 870,037 tons. These include a large number of ships of over 10,000 tons each, and all those of over 15,000 tons, classed by the Society during the past year. In each case the turbines are used in association with reduction gearing, and included in the figures is one vessel—ss. Biyo Maru, 5480 tons—in which the turbo-electric drive is employed. In this connection it may be of interest to note that of all steamers recorded in the current edition of Lloyd's Register Book, reduction geared steam turbines are fitted in 918 vessels, of 5,519,357 gross tons. The majority of these gears are of the double reduction type. The Isherwood system of longitudinal framing was adopted in the construction of 87 vessels, of 506,556 tons gross, built under the Society's survey during the year. The majority of these, viz., 69 vessels, of 471,992 tons, are intended for the carriage of oil in bulk. Vessels of all types of construction intended for bulk oil carrying and built to class in the twelve months under review amounted to 114, of 602,399 tons gross. While this tonnage is somewhat lower than the similar figure for the previous year, it represents an appreciably higher percentage—nearly 24 per cent., as compared with 18 per cent.—of the total tonnage classed during the period in question. Vessels to the number of 209, representing 1,395,929 gross tons, or 55 per cent. of the total tonnage of new vessels classed during the year under review, were fitted for burning oil fuel. The aggregate tonnage of vessels now fitted for burning oil fuel is 14,464,162, as compared with 1,310,209 in July, 1914. These figures include vessels which are fitted with installations for burning oil in the furnaces of their boilers, but it does not necessarily follow that all such vessels are using oil. Among the vessels converted during the year, under the Society's supervision, for burning oil fuel were the Aquitania, Berengaria, and Mauretania, and several other large passenger vessels.

The total number of vessels built to class during the year and fitted with oil engines was 59, of 226,404 tons, 21 of which were ships of large size, totalling 168,476 gross tons. All these vessels were fitted with engines using heavy oil. The use of internal combustion engines continues to develop. Whereas in July, 1914, there were 297, of a total of 234,287 gross tons, in July, 1922, there were 1620, of a total of 1,542,160 gross tons.

Of the 1620 motor vessels just mentioned, 341 are of 1000 tons and upwards; and of them again 130 have tonnages ranging from 1000 to 2000 tons, 98 are from 2001 to 4000 tons, 47 from 4001 to 6000 tons, and 66 are above 6000 tons. Nearly one-half of the smaller vessels depend solely on their engines for their motive power, but amongst the 341 vessels of 1000 tons and above, 93 are provided with considerable sail power. There are 229 vessels fitted with oil engines of the Diesel and "opposed piston" types, and of these, 64 are single-screw vessels. The largest of the vessels fitted with Diesel engines are the following:—Zoppot, 9932 gross tons; Glenogle, 9513 gross tons; Glenapp, 9503 gross tons; Glenbeg, 9461 gross tons; Glengarry, 9460 gross tons; and Lochkatrine, 9409 gross tons. Of the types of Diesel engines fitted, the four-stroke cycle predominates in numbers and total horse-power; but the two-stroke cycle is well represented, and some "opposed piston" oil engines have also been fitted. Some double-acting Diesel engines and a set of "Still" engines is at present under construction. The specified total brake horse-power of the last mentioned engines is 2500, and they are intended to be fitted in a twin-screw vessel of 4500t. length.

The following table, compiled from the Society's records, illustrates the relative proportions of (1) reciprocating steam engines; (2) steam turbines; and (3) motors fitted in vessels built to class during the last four years. It also shows for the same period the proportion of the tonnage built to be propelled by the medium of (*a*) coal only; and (*b*) oil, *i.e.*, as fuel for boilers or for motors. A proportion of these vessels can, of course, burn either coal or oil for steam raising.

Period.	Total Steam and Motor Tonnage Classed.	Type of Engines.			Fuel.	
		Steam Reciprocating.	Steam Turbines.	Motors.	Coal.	Oil.
	Gross Tons.	Gross Tons.	Gross Tons.	Gross Tons.	Gross Tons.	Gross Tons.
1918-1919	3,760,806	2,633,576	1,051,202	75,934	2,491,213	1,269,593
1919-1920	4,186,882	2,821,031	1,286,048 all geared	79,803	2,111,289	2,075,593
1920-1921	3,229,188	2,373,667	754,519 all geared	101,002	1,280,165	1,948,723
1921-1922	2,847,513	1,439,934	870,037 all geared	236,542	790,037	1,622,481

At the end of June, 1922, the Society's certificate in respect of refrigerating machinery—Lloyd's R.M.C.—was held by 242 vessels, of which 36 were built to class with the Society during the period under review. In addition, there are at present under construction or being fitting out under the survey of the Society's Surveyors, 30 vessels with refrigerating installations. Two of these vessels are being built in Australia and three in Germany.

The total length of chain cable tested under the Anchors and Chain Cables Act, 1899, during the year 1921-22 at the public proving houses in the United Kingdom, all of which are under the superintendence of the Society, was 168,572 fathoms, in addition to a quantity of miscellaneous chains and samples. The number of anchors tested was 3095. Ship and boiler steel tested by the Society's Surveyors at home and abroad during the year ended June 30th, 1922, amounted to 308,642 tons only, as compared with 1,451,311 tons tested during the preceding twelve months. This enormous reduction of 79 per cent. is again significant of the state of the shipbuilding industry.

Since the issue of the last report, the Committee has instituted scholarships in naval architecture and marine engineering at the University of Michigan and at the Massachusetts School of Technology, Boston, Mass. This addition brings the number of scholarships in naval architecture and marine engineering maintained by the Committee of Lloyd's Register to twenty-three. Several of them are specially assigned to the Universities of Glasgow, Durham, Liverpool and Tokio; while three are awarded through the Institute of Marine Engineers and may be held at any approved university or other centre of advanced technical education. All are tenable for three years, and application for particulars concerning them should be addressed to the registrars or secretaries of the various universities, &c.

A Seven-Day Journal.

Gas by the Therm.

The Department of Scientific and Industrial Research has just issued a neat little pamphlet, entitled "The Therm," containing reprints of the reports on gas standards submitted in 1919 to the Board of Trade by the Fuel Research Board. It was in these reports that the method of charging for gas by the therm was first propounded. We doubt very much whether the public generally, in spite of its severe criticism of the therm, will take the trouble to read and digest the reports, for they are of a somewhat technical and closely reasoned nature. In a preface, however, the Department sets forth the claims for the therm in simple language, which should appeal to all as authoritative and impartial. It is shown that the change in the use of gas for lighting purposes brought about by the introduction of the incandescent mantle, together with the growth in the use of gas fires and cookers, rendered a new gas standard based on heating value an essential development. At the same time, the old standard, based on illuminating value, prescribed by law, left the gas companies little freedom to make the best use possible of the nation's coal resources. The therm was therefore introduced, both to protect the consumer and to assist the conservation of our coal supplies. If the pamphlet does not convince the public that the therm system is sound, it would still have been worth while issuing it for the sake of clearing the ground of certain false impressions concerning the therm which have grown up regarding it.

A New Cable-laying Vessel.

It is announced that Siemens Brothers and Co., Limited, of Woolwich, have decided to dispense with the services of their well-known cable-laying vessel Faraday, and that they have placed an order for a successor with Palmer's, of Hebburn-on-Tyne. The Faraday was launched in 1874, from the Low Walker yard of Charles Mitchell and Co. In the course of her life of nearly fifty years, she has laid a total of about 50,000 miles of cable, including eight cables across the Atlantic. She is an iron vessel of 5028 gross tonnage, and carries the cable in three tanks, having an aggregate capacity of nearly 118,000 cubic feet. She has now become obsolete in several respects. In the new vessel all modern developments will be embodied. She will have a length of 380ft. and a width of 48ft., and will be propelled by triple-expansion engines, with oil-fired boilers. Her four cable tanks will provide capacity for about 4350 tons of cable, while her steaming range will be approximately 10,000 miles.

Professional Classes Aid Council.

The first annual report of the Professional Classes Aid Council, the successor of the Professional Classes War Relief Council, shows that over six hundred cases were dealt with during the twelve months, and of these, little over a hundred were refused assistance, either on account of the applications being unsatisfactory or outside the scope of the scheme. The cardinal principle of the Council is that relief should be constructive. A line is always sought which affords a prospect of rendering the applicant self-supporting. In too many instances, unfortunately, age or infirmity render any such plan impossible, the only effective relief being some form of permanent maintenance. The Council has no funds for such cases, but it has assisted numerous applicants to obtain admission to homes, or to get pensions from funds established for that purpose, and has supported them during the period of waiting. The forms of constructive relief have been varied. The most usual has been the education of children. The extent to which assistance has been given, during the past year, to members of all kinds of professions, may be judged from the fact that over £2000 was disbursed for children's school fees and expenses, while maintenance grants amounted to nearly £1500. The total expenditure on relief was £5443. The balance sheet shows that the expenditure of the Council is considerably in excess of the income, and it is to be hoped that the appeal for subscriptions or contributions will meet with success.

The Gliding Competition.

The gliding competition on the Sussex Downs for a prize of £1000 offered by a contemporary came to a conclusion on Saturday, on which day a French pilot, Maneyrolle, flying a monoplane glider entered by Monsieur L. Peyret, remained in the air for 3 hours 22 min. In so doing he not only won the prize with nearly an hour in his favour over the next best performance, but actually surpassed the previous world's record for gliding, namely, a flight of 3 hours 10 min. duration established a month or so ago by Rentzen in Germany. Several of the machines entered for the competition were of highly original design, the most curious freak perhaps being one designated a "sail biplane," in which the inventor sought to obtain additional propelling force by means of a mainsail and jib carried on a yacht's mast, which was fixed above the wings. Two ornithopters and one helicopter also figured among the entries. The machines which actually flew, however, were all of an orthodox character, although some of them showed distinct signs of being home-made makeshifts. The winning machine departed a little from familiar form by having two sets of monoplane wings arranged in tandem in the manner of Langley's historic "aerodrome" of a quarter of a century ago. After Maneyrolle's flight, the next best performance was that of Raynham, who surpassed his earlier record with a flight lasting 2 hours 26 min. Mr. Olley on a Fokker machine flew for 1 hour 27 min. 47 sec., and Squadron Leader Gray on a monoplane built of scrapped parts of a Bristol and a Fokker machine, came fourth with a flight of 1 hour 7 min. duration. No other competitor flew for as much as three-quarters of an hour.

Railway Electrification Problems.

In the course of the inquiry held in Sheffield by the Electricity Commissioners regarding the formation of the North-East Midlands Electricity District, a strong plea for special consideration for the future needs of the railways was entered on behalf of the London and North-Western and Midland railways. It was pointed out that the triangle between Chinley, Ambergate and Dore was particularly suited to electrification work, for in it there met four important streams of traffic. Not only was the density of the traffic in favour of electrification, but the gradients were stiff, and there was a tunnel four miles in length, both of which circumstances pointed to the advisability of electrifying the system. That the change-over would one day be made was, it was pointed out, quite certain, although it might not come for some time yet. The Commissioners were therefore urged to lay their plans for the district with due consideration for the practically certain future needs of the railways. In this connection, it was especially sought to ensure that the railway companies would be given the supply when they required it, and that the area over which that supply would be available would not be so restricted as to exclude important sections of the lines which would ultimately come under the electrification scheme.

Aero Engines for Motor Cars.

It has been found necessary by Rolls-Royce, Limited, to issue a statement to the effect that they are not selling, and never have sold, any of their "Hawk" aero-engines for use on motor cars, and that any such use of these engines would be without their advice or recommendation, and would be solely on the responsibility of those adopting it. The "Hawk" engine is the smallest of the four types of aero-engine made by the firm. It has six cylinders, water cooled, and develops 100 horse-power at 1500 revolutions per minute. It weighs, dry, 405 lb., and consumes 6½ gallons of petrol per hour.

New Air Service to the Continent.

On Monday the Daimler Hire Company successfully opened its new air service between Manchester, London and Amsterdam. The journey to London occupied about two hours, and after an interval of 45 minutes, was continued by the same machine to Amsterdam, which was reached in 2¼ hours. A similar machine left Amsterdam at 9.50 a.m., and reached London at noon and Manchester at 2.45 p.m. The service will ultimately be extended from Amsterdam to Hamburg and Berlin, but at present the second part of the scheme is in abeyance because the Treaty of Versailles prohibits the use in Germany of civil machines with engines of more than 100 horse-power. An International Air Conference is being held in London this week, and one of its outcomes will probably be the granting of permission to Germany to build a limited number of high-powered machines to co-operate with the Daimler and other services which desire to extend their connections into Germany.

Restoring the Victory.

In the Journal for June 23rd we recorded the fact that the Society for Nautical Research was taking preliminary steps towards restoring the Victory to the same appearance as she possessed in Nelson's time. During the evening of last Saturday, Trafalgar Day, Admiral of the Fleet Sir Doveton Sturdee, the President of the Society, enlisted the services of wireless broadcasting in the cause of the historic vessel. From Marconi House, on a wave length of 360 m., he sent out an appeal for help. It would appear that apart from restoring her to her former appearance, the bare preservation of the Victory is now a matter of anxious concern, for although she is, and has been for the past five months or so, in dry dock at Portsmouth, the prevention of further decay is taxing the ingenuity and resources of those responsible for her. The Admiralty can expend money upon her only in connection with immediate necessities, whereas to guarantee her preservation several thousands of pounds are required. The Victory is rightly associated with Nelson's name, but, as Admiral Sturdee pointed out, she was famous before Nelson's time as the flagship of Keppel, Kempenfelt, Howe, Hood and St. Vincent. She belongs not to Portsmouth, not to the Navy, but to the nation. Will the nation stand by unmoved and see one of its most historical possessions falling slowly away to dust?

Wave Transmission.

In connection with the article on the transmission of power by hydraulic waves which appears elsewhere in this issue, it is a coincidence that on Monday the Royal Commission on Awards to Inventors dealt with a group of claims from those who considered themselves entitled to rewards in connection with the design of synchronising gears for enabling machine guns to be fired through the blades of an aeroplane propeller. Those claiming consideration were Messrs. Edwards Brothers, Major Scarff, Captain Dibovsky, a Russian; Mr. George Constantinesco, Mr. Haddon, W. H. Dorman and Co., Limited, Major Blacker, Major Hartley, Captain Coote, Lieut. E. J. Hiscock and Major Hazleton. Certain of the devices submitted by these inventors were of a purely mechanical nature, whereas the "C.C." interrupter gear advanced by Mr. Constantinesco and eventually adopted on a wholesale scale embodied an elementary form of hydraulic wave transmission. Referring to Mr. Constantinesco's work, Mr. Trevor Watson, for the Crown, characterised wave transmission as one of the most important inventions of the century.

Tenders Invited for the New Warships.

We have secured official confirmation of the fact that the Admiralty has at last issued invitations to shipbuilders to tender for the two new warships sanctioned under the Washington Conference Agreement. The firms invited to tender include Vickers, Cammell Laird, Harland and Wolff, four firms on the Clyde, and three on the Tyne. The ships are to be of 35,000 tons, and contracts for them will be awarded early in December. It is stated, although we cannot obtain official assurance on this point, that the ships will cost about £6,000,000 each, and that they will provide work for two and a-half years for their builders, and result in a total distribution of about £8,000,000 in wages. The Clyde firms are, we understand, the Fairfield Company, William Beardmore, John Brown, and Scott's, while those on the Tyne to whom invitations have been sent are Armstrong, Whitworth, Swan Hunter, and Palmer's. It would appear that the vessels, while less than 700ft. in length, will have an exceptionally wide beam—106ft., according to one report.

Loss of a Hamburg-Amerika Liner.

The curious circumstances attending the loss of the Hamburg-Amerika liner Hammonia on September 9th, about 100 miles off Vigo, were subsequently inquired into by a court at Hamburg, and have now been reported upon. Very little light was shed on the cause of the disaster. It was established that the coaling ports on the starboard side were insufficiently tight, and that in the heavy weather which the vessel encountered soon after leaving Vigo, water was being admitted through them. They were duly attended to, with the result that the leak was reduced to an amount which, in the opinion of the captain, the first officer and the chief engineer, was easily within the capacity of the pumps to handle. Nevertheless, the vessel developed a list to starboard, and water began to make its appearance in the boiler-room. The pumps were set fully going, but could make no effect on the water, and the list slowly increased. A thorough examination failed to reveal any other leak beyond that at the coaling ports. The vessel subsequently sank, all but nineteen of those on board being rescued by the Kinfauns Castle and other British steamers. The court, in its judgment, accepted the view that there was some serious undiscovered leak, but did not attempt to locate it. It is believed possible that the vessel may have struck some submerged body, for at eight o'clock in the evening preceding the disaster a strong shaking was felt, which at the time was thought to have been caused by the blow of a very heavy wave. The Hammonia was built by Messrs. Stephen, at Glasgow, in 1909, and was purchased by the Hamburg-Amerika Line from the Royal Holland Lloyd in February of this year.

Chinese Engineering Notes.

(From our own Correspondents.)

September, 1922.

Peking.

At the invitation of General Chang Tso Lin, I went to Mukden at the end of last month, and have just returned after spending three weeks in that city. The General invited me to discuss with him the various economic problems in the three eastern provinces—Manchuria, Kirin and Heilungkiang—under his control, and particularly the situation as a result of his taking control of that part of the Peking–Mukden Railway between Shanhaikuan and Mukden. General Chang is still operating this line independently of the Central Government, and continues to retain a very large percentage of the rolling stock belonging to the whole railway. He has taken up a very definite attitude about this railway, and one cannot help feeling that he is in a difficult position. At our first interview, he stated quite frankly that he was prepared to return the railway and all rolling stock to the Central Government, provided he could obtain reasonable guarantees that General Wu Pei Fu—who recently defeated him—would not be allowed to take control of the railway for the purpose of attacking him. It is known that General Wu is reorganising and drilling his army, and it is not unlikely that he intends to attack General Chang, with the idea of completely eliminating the latter's influence, not only in Peking politics, but in Manchuria.

Everyone realises how necessary it is for China to build railways, but she must rely almost entirely on foreign capital for this work. Formerly, it was not difficult to obtain money from Europe or America for railways in China, because the security was good, and in practically every case the railways made handsome profits after they had been in operation a short time. Now that it appears to be possible for any Tuchun (military governor) of a province to commandeer a railway in his particular sphere of influence, the whole situation has changed, and until either the Central Government or the foreign Powers can prevent such a state of affairs, China will look in vain for foreign capital for railways. The development of this country naturally depends entirely upon railways and other means of communication, so that until the present unsatisfactory situation is cleared up, we cannot hope for the trade boom which has been so long expected. Peking is still busy "Cabinet making," and it is understood that Dr. Wang Chung Hui—one of China's most enlightened men of the younger school—will accept the premiership. Unfortunately, however, Dr. Wang's Cabinet will still have to face the military party. General Wu is still at his headquarters in Honan, some 350 miles from Peking, and continues to bombard the Central Government with telegrams regarding the formation of the new Cabinet, in spite of the fact that times without number he has stated that he will not interfere in Peking politics. The Central Government is just as much under the influence of General Wu now as it was under the influence of General Chang before the recent war. In the last war, General Wu enjoyed the support of foreigners generally and the foreign Press in particular, much to the annoyance of General Chang. A section of the British Press has been particularly hostile to General Chang and indulged in personalities not usually associated with British journalism in China. Quite apart from the history of General Chang's early career—for many years he was a bandit in Manchuria—the fact remains that the provinces under his jurisdiction are well governed, the people prosperous and to all appearances contented. It is only this fact that enables General Chang to carry on his administration after having suffered a heavy defeat in the field.

There is plenty of money in Manchuria, and it can be said without fear of contradiction that the Manchurian Government has always met its foreign obligations. It will be argued that this has only been possible because General Chang has commandeered a large portion of revenue from the Peking–Mukden Railway, as well as salt revenues, which should have gone into the coffers of the Central Government. That is true, but practically every other Tuchun—including General Wu—is doing the same thing. General Chang expressed himself very forcibly about the particular British newspapers that have been attacking him, and there is no doubt that British interests in that part of China have suffered considerably. There is quite a large British and American community in Mukden, and from time to time strong representations have been made by them to their respective Chambers of Commerce on this question of Press attacks.

British engineering firms would do well to consider the vast possibilities existing in Manchuria. In Mukden there is still an old horse tramway system, and the authorities are now prepared to receive proposals for converting it into an up-to-date electrical undertaking. The system is to be considerably extended, and will involve the construction of some 40 miles of permanent way and all the necessary power station plant, overhead equipment, &c. Private inquiries are also being made by some Chinese capitalists for a complete electric lighting plant for a town in Manchuria. The Manchurian Government has also under consideration a very extensive system of long-distance telephones. I am enclosing with this letter a few photographs of the fine building of the Kailan Mining Administration at Tientsin, as they will give your readers a good idea of the way in which China is developing on European lines. You have probably already published an article on the Kailan Mines which I sent you some weeks ago.*

FRONT FACE OF THE KAILAN MINING ADMINISTRATION BUILDING AT TIENTSIN

Shanghai.

As the development of the port of Woosung is likely to become of paramount importance to Shanghai and to the trade of China, a return to this subject may be excused. An outline map is attached to this letter showing the position of Woosung relative to Shanghai and the Yangtsze River. A detailed survey of the whole district between Shanghai and the Yangtsze River has been completed and Woosung is being planned on modern lines with industrial, residential and business districts, with parks and good roads. A road running direct to the eastern district of Shanghai settlement is projected, and a bridge of reinforced concrete is to be built over the Woosung Creek, which is 300ft. wide and has a depth of water at low tide of 12ft. Waterworks, electric light installation and drainage schemes are being drawn up. In fact, the Woosung Port Development Administration, with his Excellency Mr. Chang Chien as Chief Commissioner, is a body with which manufacturers interested in the supply of the equipment

* See THE ENGINEER, September 22nd, 1922.

required for the various undertakings mentioned above should get in touch.

The remark has been made above that the development of the port of Woosung is important to the trade of China. This importance arises not only from the fact that the port development will call for a certain quantity of machinery, but more so because it indicates a serious effort on the part of the Chinese to strike out on their own account. They have attempted to do so before at Pukow, the port on the Yangtzse opposite Nanking, and at Hulutao, on the coast of the Gulf of Pechili, but in the case of Pukow nothing in the way of development has taken place, except along the river front, where some go-downs and crude moorings for steamers have been constructed. The Tientsin-Pukow Railway Company, having its southern terminus there, has built a fine station and wharf, but no factories or other industrial developments have been attracted to the port. The oil companies have, with their usual enterprise, got installations there, but their tanks and go-downs are familiar objects at many places where no other concern will venture, and they may be said to be part and parcel of the transportation use to which the port has thus far only attained. Hulutao is desolate, and shows nothing but works begun years ago and left to rot. A new effort was made recently to go on with the development of the port, but the work has again been shelved. At Woosung the outlook is different. Already there is a Chinese investment of about £6,000,000 in cotton mills, a sugar refinery and roads, and, as has been stated, much enlightened development is contemplated. The reasons for expecting a concrete future for Woosung are various. Its unique position on the great Yangtzse trade route under the wing of Shanghai, its powerful board of directors, and its necessity as a relief to the congestion of Shanghai. It has been indicated in previous notes that it would be advisable for us to have a hand in the financing of these developments, and it can be gained by arrangement with the Administration, and secured on land taxes, rates, wharfage dues, &c.

Hong Kong.

The disaster at Swatow, caused by the terrific typhoon and the tidal wave which followed it, reminds us once again that the most efficient missionaries in China are the members of the engineering profession who are doing their best to persuade the Chinese to take full advantage of the scientific knowledge that is available. The first reports of the damage came to this Colony early in August, and it is now believed that 50,000 people in the district lost their lives. It is not clear whether any warning concerning the probable approach of the typhoon reached Swatow. In this Colony we have an excellent observatory, a most elaborate system of signals, and the naval wireless station. The dreadful death-roll of sixteen years ago, when an unexpected typhoon struck Hong Kong, taught the local Government a lesson which has never been forgotten, and it can be said that if another typhoon came here, although there would be some damage done, it would be negligible as compared with that recorded in Swatow. The only building that escaped in that Chinese town was one made of reinforced concrete. The most practical thing that the Chinese could do would be to ship some thousands of tons of steel bars and cement to Swatow for re-building purposes. The old style of native construction must give way to modern European style. There is, of course, a wonderful chance for the erection of a model city planned by experts. Unfortunately, this plan will not be followed, because China has neither the Government nor the money necessary to carry out such a scheme. It is almost certain that the foreign firms interested in the Swatow trade will erect reinforced concrete go-downs. Alfred Holt, Limited, were the pioneers in that work in this Colony, and now it is common practice. We have our own local cement works, and we import a great deal of steel.

Recent cables from Home report an interview in London with Sir Paul Chater, past-chairman of the Hong Kong and Whampoa Dock Company, Limited, and the "Father" of the Colony. Sir Paul has

MAP SHOWING POSITION OF PORT OF WOOSUNG

repeated in London what he has often told the writer, viz., his hopes of persuading the Chinese to open up the coal mines of the province of Kwangtung. If he does succeed in getting cheap coal in Hong Kong, then this Colony will become in a very few years one of the largest manufacturing places of the world. Already it has, in the eighty years of its existence, grown from a home of a handful of pirates into the largest port of the world. Its population in 1842 was not more than 5000; it is now nearly 700,000. If we have cheap coal, the population will become 5,000,000 in a few years. Nothing can prevent the growth of enormous steel works and kindred industries. Steel, ships and engineering plant will then be manufactured here at a price well below that which obtains in Europe and America.

The crux of the problem is the unlimited reservoir of cheap labour in the Chinese provinces behind Hong Kong. Of course, there will be great difficulties because of labour agitators; no doubt wages will rise a great deal. When full allowances for all these factors have been made, it must be remembered that there are millions of quite intelligent and most industrious men in South China—the Cantonese—who at present eke out a precarious existence and who would actually sell their lives in order to ensure that their families had sufficient food. The immediate effect of cheap coal in Hong Kong would be a great demand for all sorts of engineering appliances. This generation in Great Britain would receive full benefits because of these orders. Whether, finally, the result of Chinese industry would be a reduction in the scale of living of future generations in Britain is mere speculation. If it be asked why this Colony should have such a future rather than Hankow or Shanghai, the reply is, "There is security here." The local Government is just, it maintains its authority and it encourages industrial development. In China the officials prey upon industry, and the Chinese know it.

OFFICES OF THE GENERAL MANAGER AND ASSISTANT TO GENERAL MANAGER IN THE KAILAN MINING ADMINISTRATION BUILDING

WATER POWER IN ARGENTINA.

The Minister of Public Works of the Province of Mendoza, Argentina, has submitted to the Legislature of that province particulars of a large scheme for the exploitation of the water power which is now going to waste, and which, the Minister says, can be economically utilised for the generation of electrical energy and the irrigation of 625,000 acres of land.

There are several rivers in the mountainous parts of Mendoza which engineers believe can be effectively harnessed, but the project under consideration is believed to be the most practicable and easiest of early development, provided foreign capital can be interested in it. The river Atual runs strongly from the south to the north-west of the province, following an unbroken course for some hundreds of miles. At the town of Nihuil it converges into a fairly narrow canyon with granite walls, and then suddenly drops 310ft. in a distance of roughly 550ft., in cataracts that are famous for their beauty. A tremendous volume of water is precipitated through a course which the river has formed in the granite, the flow being estimated at 550 cubic yards a second in flood time, with an average discharge all the year round of 45 cubic yards per second. At this point the Government of Mendoza proposes the construction of a plant to generate from 40,000 to 100,000 horse-power of electrical energy, and by damming the river to provide an even flow of water all through the year and to irrigate over 600,000 acres of the rich southern part of the province.

Government engineers point out that from Nihuil to Mendoza, a distance of barely 300 miles, electrical power can easily and cheaply be conveyed for lighting and industrial purposes. At present the generation of energy for light and power involves a long haul of fuel from Buenos Aires, and to produce 40,000 horse-power by the most perfect engines of the Diesel system would require a consumption of 70,080 tons of crude oil per annum.

The Minister has asked the Legislature to pass a law authorising the calling of tenders for a concession to be granted for the installation and operation of the hydro-electric plant at Nihuil, notification to be given in all foreign countries, with a term of six months for the submission of offers. The following are conditions governing the concession, as suggested to the Legislature:—The concessionnaires must undertake to carry out whatever scheme they propose, the sole compensation being the right to operate it for their own account for a number of years to be specified, and at the end of that period deliver the plant and installation in good working order to the Government; submit a tariff of charges for light and power, this tariff to be subject to revision every five years; state what percentage of the financial receipts they will pay to the province; undertake to begin work six months after the signing of the contract and make a deposit of 100,000 dollars paper for faithful compliance. For its part the Government will exempt the concessionnaires from taxes and imposts during the currency of the concession, and will spend 10,000 dollars in making the preliminary studies and topographical survey.

It is anticipated that the Legislature will approve the scheme in its entirety and proceed at once to give effect to it. Full details of the project can be obtained from the Minister of Public Works, City of Mendoza, Argentina.

Terms have been agreed for the absorption by the London and South-Western Railway of the Isle of Wight Central Railway. Fourteen subsidiary companies are to be absorbed into the Southern group, and as yet with only two—the Lee-on-the-Solent and the Isle of Wight Central—have terms been arranged.

The Physicist and the Electrical Engineering Industry.

A lecture entitled "The Physicist and the Electrical Engineering Industry" was delivered on Wednesday, the 18th inst., before the Institute of Physics, by Mr. C. C. Paterson, chief of the research organisation of the General Electric Company, Limited. The author began by saying that there were, in the main, three ways in which physicists might be associated with the electrical industry. First, they might work at independent investigations and research at universities with no immediate industrial objects in view: secondly, they might work with a definite industrial object at institutions outside the industry, such, for instance, as the National Physical Laboratory, and be included in that category the various industrial research associations; thirdly, they might engage in research and investigatory work with an individual company and in the employment of that company. It was the last category that he wished to consider most, not because he desired to belittle the importance of the other two categories, but because he thought the need which industry had for the physicist within itself was very insufficiently appreciated.

The electrical industry could, said Mr. Paterson, never flourish if it relied on merely receiving the results of physical investigations from outside. The outside investigator, however brilliant and however frequent his visits to works, could never have sufficient knowledge of the industry to appreciate fully what are its real needs or what are the real facts of its problems. He wished to convince them of the urgency of the necessity for having physicists of the right sort at the heart of an industrial concern, intimately associated with its manufacturing processes and in the counsels of the management in all matters of policy which might be affected by technical considerations, and the elaboration of that aspect he had taken as the theme of his lecture.

He would endeavour to give as true a picture as he could of many well-managed manufacturing concerns in the electrical and allied industries. It was of no use to consider the industry as a whole. The industry consisted of a number of manufacturing units, entirely independent and generally in competition; usually the competition was in price as well as quality. Competition in quality always existed, and low manufacturing costs came only second in importance to quality. Sometimes even a compromise between costs and quality had to be admitted. Although it might not always be the case, he would assume that technical processes in the works were in the hands of men whose mental equipment was good. Often they were qualified engineers. Frequently these men had the main executive responsibility in their departments, and had to see to the putting through of orders and the quality and design of the articles manufactured. Sometimes they were qualified men on the staff of the works chemist, or the works chemist himself was in charge of the processes. On the other hand, in some branches of the industry, a chemist was not considered necessary, or was relegated to an inferior position, and the factory processes were in the hands of an engineer to whose shoulders all the production worries were transferred. In other cases, technical responsibility largely rested with the staffs of the drawing and designs office.

Whoever was made responsible for factory processes and production was usually given a free hand by the management to make whatever trials and experiments he wished with a view to improving and reducing costs. Most managements prided themselves on the encouragement given to their staffs to make experiments. This had the incidental advantage to the management of affording less ground for excuse on the part of the technical staff should processes go wrong or complaints arise. Alterations in processes or designs sometimes came from inside; often they were the result of pressure from competitors. Information, often incomplete, was received that a competitor was working along some new line, and the technical man responsible for that section was immediately set to work to reproduce the result. If he succeeded up to the point of making the new process or design an improvement over the old, it was adopted in the factory after a fairly thorough trial, and there the matter ended. There was no time for more. Empirical instructions had been given to the factory, and meanwhile the next worry had been taken up in order of urgency. More often the attempted improvement was discarded as unworkable for reasons which were never very clearly defined. Either it was beyond the technical skill or knowledge of the man responsible, or there were factors connected with the raw materials which were outside his control. Often, improvements which were at first promising had been discarded because the results had proved erratic and uncertain in routine production, and the investigation of the causes by the usual trial and error methods was a task of too great magnitude and was too expensive to face.

To a greater or less extent this was, or had been until recently, a true picture not of one, but of the majority of the concerns connected with the British electrical engineering industry. It was also a picture of as many foreign ones. Looked at from the point of view of what might be, it was, from a technical point of view, a picture of "muddling along," frequently at low efficiency, nearly always in an atmosphere of semi-ignorance as to what it was doing, constantly fearing that the products it was supplying might develop unexpected blemishes the cause of which were shrouded in obscurity. He did not think it compared unfavourably with the average standards existing in many industrial countries throughout the world, but he was comparing it with what was well within the power of the industry to become.

These uncertainties and mysteries in industry must be explained, and for several reasons other than the obvious one. They could only be cleared up by knowing what are the physical laws which underlie its processes and govern the behaviour of its products, and this knowledge must be part and parcel of the factory equipment, and must not be regarded as an academic thing, the property of one or two experts. Industry run by engineers was constantly satisfied by merely getting something to work, whether it be a process or a finished product. To do anything more was considered a waste of money. To learn the why and the wherefore was relegated by the management to universities and places where they think. If the results of this policy were not so disastrous for industry itself, one would have little to say, but it was vital in the interests of industry itself that it should change its outlook and recognise that knowledge is as valuable to it as practical achievement. At present many concerns depend for subsistence on crumbs of knowledge picked from under the table of the universities, and that was a meagre meal for an industry which ought to be growing. It was sometimes stated by managements that they could rub along all right with their existing technical staffs. If they came up against a problem which they could not manage, and if it was of sufficient importance, they called in outside research assistance, but this outside assistance could never take the place of the physicist at the heart of a concern.

For a works physicist to be a success, however, it was essential that both the physicist and those with whom he must co-operate should learn each other's points of view. Their mentalities were different, and must, and should be, different and complementary. Without this understanding there never could be fruitful work, and particularly must the works manager appreciate that the true research worker is originally minded and therefore finds control irksome. Each side must win the confidence of the other and merit the support and appreciation of the other, for the success of physics in industry depended as much upon these matters as on the actual merit of the researches carried out.

The first desideratum for the physicist was to know his works thoroughly. The physicist who entered many branches of the electrical manufacturing industry was struck by how empirical everything is. That the industry had been carried on successfully under these conditions was a tribute to the ability and patience of the *personnel* of the industry. It was a great mistake to assume that other methods could easily and quickly supersede empiricism, but they must gradually do it as principles become really surely established. One of the most baffling factors in the process of substituting control by measurement for control by judgment was when a factory had not the full control of its raw materials but had to take what it was able to purchase. Variations in raw materials might completely mask the effect of refinements introduced to improve efficiency. In these circumstances, there was greater need for the physicist or the works chemist, as the case may be, in order to introduce processes for the treatment of raw materials, or to show the suppliers of the raw materials what to do in order to meet requirements. The only way to expect success was to make the research physicists free lances in the works, free to arrange their own experiments and to set themselves their own problems untrammelled by the prejudices of the existing works *personnel*. Their only terms of reference should be to investigate the works processes and products with a view to the improvement of efficiency and the development of better ones. They must have a laboratory of their own and workshop facilities under their own control. The number of men would depend upon the size of the concern, but two was an absolute minimum, and the qualifications would naturally depend on the particular branch of electrical engineering in question.

Many industrialists would be inclined to regard with incredulity the wisdom of letting physicists loose in their works with such a roving commission. They might see difficulties of discipline, of jealousy on the part of the works *personnel*, interference with production and overlapping with the duties and responsibilities of superintendents and others already responsible for experimental work. They might regard it as likely to turn into a new department responsible to none of the existing works managers, with direct access to the managing director himself over the heads of those responsible to him for the works. These were, admittedly, great considerations, but it was nevertheless of the greatest importance to segregate the research men from the existing works influences and control and to get the managers to support and welcome this segregation.

Dealing with the application by the General Electric Company of the ideas he had propounded, Mr. Patterson said that the company decided four or five years ago to make research one of its definite objectives. Practically the only general fundamental principle the management laid down in connection with this decision was that the research activities were to be kept independent of production activities, *i.e.*, the works must maintain their complete responsibility for production processes. The research organisation should assist with advice and experiment in a consultative capacity and the problems they tackled and the work they undertook must remain in the discretion of the research organisation itself. On the other hand, the decision to apply or not the results of any piece of work of the research laboratories must rest entirely with the factory concerned with the particular product. With this guiding principle and the financial means to establish laboratories the movement was launched into the company's activities to work out its destiny, supported by the good will of the various managements—to establish its relationship with the different works of the company, and to grow as circumstances should dictate.

The arrangement was absolutely flexible. Occasionally, experiments were conducted on the production plant itself—more often, if it could anyhow be arranged, the process was installed in the research laboratories where factors could be independently controlled and where production was not interfered with. Moreover, the practice had grown up of holding regular meetings of the works technical staffs with members of the research laboratory staff. Works technical matters were reviewed at these conferences, and the laboratories were able to acquaint themselves with the works policy and their urgent problems and difficulties. The whole *personnel* of the laboratories now numbered eighty, of whom 25 per cent. were qualified research men, and of the remainder a good many were operatives who carried on some of the works processes on a small scale in the laboratory for the purpose of studying them and applying experimental results in a practical way before recommending them to the factory.

Mr. Patterson concluded with a reference to some instances of the manner in which research work in the factory has been productive of practical results in a manner which would not have been possible otherwise. A certain process in the works which had been in use for a long time involved the coating of wires of different diameters with a material which hardened after coming out of the bath. The final product was not always uniform in quality and there was considerable wastage due to outfalls, and consequent loss of money. Investigation showed that there were as many as six variables affecting the final product, several of them interdependent and concerning processes carried out, and products made, in different departments of the factory. One of these was the quantity and uniformity of the deposit on the wire, which became increasingly variable as the size became smaller. The problem was tackled by making measurements with a view to determining the laws governing the deposition of liquids, with and without suspensions, on long cylinders when suspensions were made. The limiting conditions were found, and the lines indicated along which alone it was possible to look for success in the operation. No works technical engineer or manager would, or even could, undertake such a piece of work as this.

Again, in the manufacture of a certain composite wire, the drawing process did not always yield 100 per cent. output. A bad patch was frequently met, and at these times the efficiency was very low. Careful micrographic examination of the wire at all stages resulted in the cause—and remedy—being found after four or five weeks' work, and the examination revealed a condition of the wire which explained the cause of many troubles which occurred in another department of the works, and had been attributed to other causes altogether. The following example is from a lamp works. The final state of evacuation of a lamp depends on the action of a certain amount of red phosphorus introduced into the lamp before sealing off from the pump system. It is known by the elegant name of "getter." Phosphorus has been employed for this purpose for very many years in the lamp industry. For many years also, lampmakers have rung the changes upon many different ingredients to add to the phosphorus and also upon the method of its introduction into the lamp. Nevertheless, all lamps have not always been perfect. Many possible causes have, from time to time, been blamed for failures, including the "getter." The whole problem was clearly one for finding out the fundamental action, not only of the getter, but of every other agency in a lamp—and there proved to be several—which affects the quantity of free gas in the bulb at different periods of the life of the lamp. The whole of the phenomena were investigated and correlated in about two years and reduced to proper physical terms. The complication of the whole problem thus revealed in its full magnitude showed the utter hopelessness of attempting to carry on manufacture intelligently by the process of groping and guessing among empiricisms.

In the design of thermionic valves there had been the great advantage that the modern physicists was fairly early in the field and had got his principles generally clear before manufacture took place on a large scale, and it was, in this case, possible in some measure to avoid empiricism from the beginning. The same, however, did not apply to acoustics, for, in spite of the fact that the telephone was one of the oldest interests, the principles and practice underlying the faithful magnification of sounds were virtually unknown. The electrical engineers throughout the world were suddenly confronted with the necessity of supplying loud speakers in connection with the magnification and reproduction of speech and music by wire and wireless, and they had little but empiricism to go upon. The industry could only hope that the public would have patience with them until the problem had been properly explored by physicists and the results of their work translated into practice.

He could imagine few things, concluded the lecturer, more beneficial to a factory or helpful to a progressive works staff, whether glass works, cable works, machinery works, or lamp works, or any other kind of works, than an invitation from its management to a band of men, physicists and chemists, to devote themselves to its welfare and improvement in the manner he had indicated. At the same time he could imagine few things more disturbing than this to a works technical staff which had allowed itself to crystallise out and had no real desire to depart from the methods of tradition and empiricism.

The Institution of Automobile Engineers.—We are, we confess, confirmed diners-out; we have eaten as many as three public dinners on an evening. Small wonder if we are grown a trifle *blasé*; small wonder if confederate feeding sometimes palls upon us. But there is one annual dinner that we purpose, under the will of Providence, always to attend—the dinner of the Institution of Automobile Engineers. That Institution can no longer claim the distinction of being the youngest in years of our technical learned societies, yet it remains the youngest in fact. Serious enough it is at times, but it remembers that the wise man is never serious at meals, and as consequence its dinners are joyous affairs. At that held on Wednesday last at the Connaught Rooms—the biggest yet—ladies for the first time were present. It was interesting to watch their faces. Had Barrie been there he would have seen a "mothering" look in them. They plainly regarded it as a children's party. We all knew—we all felt so young—that they would take us home presently, give us paregoric, and put us to bed. We believe there were speeches, too—there was certainly a toastmaster in a red coat who sat on a radiator behind the chairman—but even he could not make the occasion solemn. We see from our card that Lieut.-Colonel J. A. Cole proposed "The Institution," and that the President, Colonel D. J. Smith, replied. That Mr. George Watson, immediate past-President, gave the toast of "The Guests," and that Sir Evelyn Murray, of the Post Office, acknowledged it. We have even got notes that there was much laughter, and that there was loud applause when one of the speakers announced that joint action for converting the Horse-power Tax into a Petrol Consumption Tax was to be taken. But none of the speeches were portentous. Then Mr. Charles Tree sang several songs admirably, someone else exhibited an improved gramophone, and finally, and best of all, there was a brilliantly amusing "wireless" stunt—a mock speech by wireless telephony from America that left one wondering if it were genuine or not till the American accent got mixed—on the aerials, we suppose—with just a *soupçon* of London! And so a happy evening came to an end, and as we went out we overheard one lady say to another, "Isn't it nice to see them enjoying themselves?" Clearly we were right; they thought it was a children's party! May the Institution ever preserve such youthfulness!

Railway Matters.

At a meeting of the Great Northern board of directors last week Sir Frederick Banbury, the chairman, intimated that he did not wish to be nominated as a director of the Eastern Group.

The Baldwin Locomotive Works have an exhibit at the Brazilian Exhibition, Rio de Janeiro, in which is a model of an American locomotive and three cars. The wheels revolve and the landscape behind the train moves, so that there is the perfect illusion of a moving train.

Arrangements, it is said, have now been concluded between the German and Yugoslavian Governments, according to which 3000 railway vehicles are to be delivered by Germany to Yugoslavia, representing the whole sum due to the latter country as reparations. The rolling stock consists of passenger coaches and goods wagons for normal and narrow-gauge lines, and will be delivered during the first half of next year.

The Railway Board of India has sanctioned a detailed survey being carried out by the Bengal Nagpur Railway Company for a line of railway on the broad gauge from the Hesla terminus of the proposed South Karanpura Coal Fields Railway *viâ* Gola and Thulin to Chandil—a station on the Adra Sini section of the Bengal Nagpur Railway—a distance of about 70 miles. The survey will be known as the Hesla Chandil Railway Survey.

Constructional work on the Antananarivo-Antsirabe railway in Madagascar, which will connect the rich region of Vakinankaratra with the chief town of the colony, is being rapidly pushed forward. The station at Ilempona, situated at the 98th kilometre, was opened for service on October 1st. On December 1st the Ilempona-Sembaina section is expected to be opened. The latter station is situated at 121 kiloms. from Tananarivo.

In the draft of the Bill for the amalgamation of several light railways in North Wales the Welsh Highland Railway Company proposed that for five years it should be exempted from local rating. As the local authorities were putting up £29,000 for the scheme they objected to this course, so that the railway company modified its proposition to two years' exemption. That not being acceptable either, the clause is to be entirely withdrawn.

Some of the starting and of the backing signals at Paddington Station, Great Western Railway, can only with difficulty be seen by drivers in the station, and they therefore have repeating, or duplicating, arms inside the station. These repeating arms are now being replaced by light signals, giving orange, for "on," and green, for "clear," indications. The lights are switched in electrically in accordance with the position of the arm they repeat.

In this column of our issue of September 8th we announced that, in connection with the centenary in 1925 of the opening of the Stockton and Darlington Railway, the International Railway Congress Association would hold a meeting in London during the second half of that year. From the "Proceedings" of the permanent Commission now to hand it appears that the Spanish Government has agreed to its invitation to Madrid in 1927 being extended to 1930.

The number of ton-miles of freight carried by the United States railways during the first six months of the present year was 152,435,057,000 as compared with 146,832,606 in the corresponding period of 1921. The revenue, though, decreased from 1,863,986,628 dols., or 1.269 cents per ton-mile, to 1,859,121,583 dols., or 1.22 cents per train mile. The passenger miles decreased by 2,000,000,000 miles, and the receipts per passenger mile from 3.127 cents to 3.049 cents.

According to statistics prepared by the United States Forest Products Service, in co-operation with the American Wood Preservers' Association, 55,383,515 sleepers were treated during 1921, for which 76,513,279 gallons of creosote and 51,375,300 lb. of zinc chloride were used. Ten years ago the number treated was only 28,394,140. In treating sleepers with creosote, an average of 7.21 lb. per cubic feet was absorbed. With zinc chloride the average quantity forced into the wood was 0.48 lb. per cubic foot.

The European Railway Congress meeting in Paris, as a result of the Genoa Conference, has been described as a technical conference. That is because the schemes that the Congress is discussing—the supply of wagons, customs examinations, imposition of charges to suit variations in exchanges—are subjects dealt with by *les services techniques*. Actually, they are what in England and America would be regarded as traffic questions. We make this explanation because the Berne International Commission—*l'Unité Technique*—is still in existence, and it deals with all international technical questions.

Engine turntables, since their first introduction, have been supported from the centre, and as the weight of the locomotives has increased it has become difficult to carry long, heavy locomotives on a single support. A form of articulated turntable has been designed and patented by the Bethlehem Steel Bridge Corporation, and has been supplied to the New York Central, Chesapeake and Ohio and Atlantic Coast Lines, wherein the load is taken at the ends also. The table is turned by electric motors on trucks at the ends, and a feature is a heavy, rigid circle rail of uniform elevation and alignment that will ensure the smooth operation of the table.

From a statement made by Mr. Cramp, the industrial secretary of the National Union of Railwaymen, it appears that the companies have submitted to that union and the Associated Society of Locomotive Engineers and Firemen further proposals which may lead to reductions in the men's pay. These payments relate to night duty and to the eight-hours' day. The *Railway Review*, the organ of the National Union of Railwaymen, says that the proposals mainly relate to the guaranteed week and guaranteed day, and payment for Sunday, Christmas Day, and night duty. There are also proposals regarding mileage turns for locomotive drivers and firemen, promotion and seniority, and preparation and disposal of engines.

Notes and Memoranda.

At the recent meeting of the Royal Philosophical Society of Glasgow, Professor Whiddington gave a demonstration with a piece of apparatus capable, he said, of measuring changes in length so small as one two hundred millionth of an inch, of which the essential feature is a thermionic valve.

A new type of glazing that does not shatter consists of alternate plates of thin glass and celluloid, treated with a solution of fusel oil, camphor, and methyl salicylate. The assembled laminæ are immersed in the solution at a temperature of 75–95 deg., and pressure is applied to the whole as the temperature is gradually increased, thus firmly cementing the plates together.

The official report, which has just been issued, concerning the explosion of a boiler on a Romford farm emphasises the faults of cleaning doors bolted on to the outside of the boiler shell by studs. The boiler in question was worked at only 18 lb. to 20 lb., and the door was about 8in. long by 4in. wide. It was held by two ½in. studs, one of which broke, allowing the contents of the boiler to escape and badly scalding the attendant, who was also the owner.

A study of various methods of evaporation and oxidation of cracked petroleum spirits leads to the conclusion that gummy and resinous deposits are caused by oxidation, and have no direct relation to unsaturation as determined by solubility in sulphuric acid. A study of gums and their formation described, carried out by the American Bureau of Mines, leads to the conclusion that they are polymerised aldehydes, which probably are formed by the oxidation of olefins, &c.

An experimental transmission line for operation at 600,000 volts was recently completed at the Purdue University. The line is 1700ft. long, and consists of three 600ft. spans of steel core aluminium cable, supported on four steel towers 65ft. high. The cross arms are 40ft. long, and the fifteen-unit suspension insulators are hung in a manner so that they may be readily moved in different directions from 16ft. to 40ft. without taking down the cables. The first study to be undertaken is that of corona losses.

Sulphur is found in many parts of China, and also in Japan and Formosa. In Yunnan the mineral exists in its pure state in districts in the north and west of the province, as a deposit at the sources of hot springs, but owing to the lack of transport facilities and high cost of freight it is not exported. A considerable amount of sulphur is also produced in Hunan by the distillation of iron pyrites, principally in the districts of Pinkiang, Hsinhua, and Chenchow. In Shanshi, in the Taiyuanfu plain, there are rich deposits of sulphur; while in Szechwan, Honan, Kweichow, Shantung, and Manchuria sulphur is manufactured partly from pyritiferous shale and partly from the sulphide ores of zinc and lead.

In the course of a paper on ball bearings for mining work, read before the Manchester Geological and Mining Society, Mr. A. Macauley said that rustless steel, which was called for in the case of bearings working in the presence of water, had the peculiarity that, when working under running water, the efficiency fell off very considerably, in addition to which its performance was very inconsistent. The indications at the moment were that such bearings could only be permitted to deal with very light loads and would be considerably more expensive than the standard production. Investigation was proceeding, however, and it was hoped that the ball bearing manufacturer would be able to supply at reasonable cost rustless bearings for mining and other work.

The *Svensk Handelstidningen*, of Stockholm, reports that there has been a considerable increase in the export of Swedish cement lately, the total amount shipped abroad during August being 7657 tons, compared with 1279 tons in August, 1921. Exports for the first eight months of the present year amounted to 54,439 tons, as against 19,293 tons during the same period of 1921. Imports of cement during the period January–August this year amounted to 11,650 tons, compared with 10,211 tons during the first eight months of 1921, but imports have shown a reduction lately, the figures for August being 1301 tons, compared with 5376 in August, 1921. Exports, however, have not yet reached the pre-war standard, the total for 1913 being 137,074 tons.

The use of a small direct-arc electric furnace for making small experimental heats of alloy steel is attended with difficulty in the control of the carbon content, but it has been proved at the Cornell University that indirect-arc types, such as the Stassano, Rennerfelt, allow much better control of the carbon content. When a raw material is used sufficiently low in sulphur and phosphorus to obviate the making of refining slags, and straight melting, analogous to crucible steel practice, is done, the making of special alloy steels in 50 lb. to 100 lb. heats, to chemical specification, is relatively simple in a 50-kilowatt indirect-arc furnace after the behaviour of the ferro-alloys to be used is known, and the behaviour of such alloys can be conveniently studied with the furnace.

According to the latest returns by the National Federation of Iron and Steel Manufacturers, the production of pig iron in September amounted to 430,300 tons, or 18,600 tons more than August, and the highest figure attained since February, 1921, when production amounted to 463,600 tons. Production is still, however, only 64 per cent. of the average monthly production in 1920 and 50 per cent. of the average monthly production in 1913. The furnaces in blast at the end of the month numbered 139, or 13 more than at the end of August. The production included 123,700 tons of hematite, 137,800 tons of basic, 113,400 of foundry and 25,900 tons of forge pig iron. The production of steel ingots and castings amounted to 555,900 tons, a figure higher than in any previous month since December, 1920, when it was 746,600 tons. This represents 73 per cent. of the average monthly production in 1920, 87 per cent. of the average monthly production in 1913, and about 50 per cent. of the steel-making capacity of the country.

Miscellanea.

The Council of the British Cast Iron Research Association has offered the important position of director of research to the Association to Dr. Percy Longmuir, M.B.E., of Sheffield, which he has accepted. He will take up his duties on November 1st.

The All-China Chamber of Commerce has decided to hold a Domestic Manufacture Exhibition in Peking in March or April next for the promotion of general interest in domestic manufactures. The Ministries of Interior and Agriculture and Commerce have submitted a petition for the approval of the President to this effect.

In a report to the Governor of the Chinese Metropolitan Area, the district magistrate of Fangshanhsien, Chihli, says that a petroleum well has been discovered in the vicinity of the district under his administration. The Ministry of Agriculture and Commerce has despatched technical experts to institute investigations on the spot and ascertain its value.

There is not the slightest doubt, said Mr. Max Lawrence in his presidential address to the Institution of Production Engineers, that the movement which prompted your Council and the original members to form this Institution is sound, and, in spite of all you may hear to the contrary, there is plenty of scope for its activities. It is doing, and will do, very valuable work for production engineers that existing institutions cannot do, or at any rate at present are not accomplishing.

Safety Pamphlet No. 7, which has just been issued by the Chief Inspector of Factories, includes a number of recommendations on the use of abrasive wheels, intended to minimise the risk of accident. The proposals are all well appreciated by engineers, and most of them are followed in well-conducted factories, but the pamphlet has the merit of putting forward the whole subject in a concise form, and of emphasising the necessity for safeguarding fast-running grinding wheels.

An experimental process for producing a ductile and stainless iron electrolytically from pyrrhotite is being tested by the Consolidated Mining and Smelting Company of British Columbia. The ore is obtained as a waste product in the concentration of lead-zinc ore from the Sullivan Mine. The iron can be rolled cold to a thousandth of an inch, and then doubled over fifty times without cracking. When the new concentrator at Kimberley is finished, it will treat 1500 tons of Sullivan ore daily, of which 375 tons will be metallic iron.

The Electricity Commissioners have decided to grant the application of Liverpool Corporation for a special order authorising, *inter alia*, the purchase by the Corporation of the undertaking of the Liverpool District Lighting Company, which supplies electricity in Great Crosby and Waterloo-with-Seaforth. There will be a substantial reduction of prices under the order, and Liverpool will become the electricity authority for the whole of the city of Liverpool, the borough of Bootle, and the urban districts of Litherland, Waterloo-with-Seaforth and Great Crosby for forty-two years from January 1st, 1922.

The city of Florence is about to enter into contracts for entirely new telephone equipment, to be installed and in working order within the next two years. The present scheme contemplates the placing of all cables underground. The Florence section forms part of the Italian State telephone system, from which all contracts are negotiated by the Central Administration at Rome. It is proposed to replace defective telephone equipment in Italy as rapidly as possible. The city of Leghorn has also resolved to expend 4,000,000 lire (£40,000 at present rate of exchange) upon telephone improvements.

A pamphlet, entitled "Research Work in Progress," has just been issued by the British Non-ferrous Metals Research Association, of 71, Temple-row, Birmingham. From it we learn that the investigations in hand cover many important problems of the copper, brass, aluminium, nickel and lead industries, as well as subjects of importance to all users of such metals. The Bureau of Information of the Association also seems to be doing excellent service in distributing to members reports of the results of the experimental researches, and acting as a live intelligence service, collecting and circulating information likely to be of use to the industry, from all parts of the world.

The strike in the engineering industries at Havre has terminated after lasting nearly four months. In view of the hopelessness of the struggle, increasing numbers of men had been returning to work for some time previously, and, finding that they were beaten, the Communists finally gave in, with the result that all the men have accepted the 10 per cent. reduction in wages. The seamen's strike also appears on the verge of collapse. At Marseilles there is a considerable reduction in the number of men holding out against the suppression of the eight hours' day, but the *inscrits*—that is to say, the seamen who may be mobilised for naval service, and are chiefly drawn upon for the Transatlantic and other steamships—are agitating for a general strike. This is apparently the last effort to arouse the flagging spirits of the seamen, and there is every reason to believe that the strike will end very shortly.

Speaking of wireless apparatus in his presidential address to the Institution of Production Engineers on October 20th, Mr. Max Lawrence said delicate apparatus has to be manufactured in large quantities, and it may sound quite easy to the scientific engineer to make a condenser having a capacity of 0.035 microfarads, but it is quite another thing to make such things in quantities of hundreds of thousands. The measuring instrument is so delicate and the current used so small, that the most sensitive telephonic apparatus has to be employed, and can only be used in a church-like silence. The hand of the operator must not approach within 1ft. of the standard, because it has a capacity considerably greater than the tolerance allowable when approached, say, within 3in. of the measuring instrument. It is true that the designers and the expert electricians realise these facts, but they have to rely upon the production engineers to make these devices in such a form that it is possible to multiply them in the time and at the price that will make an appeal to a very large public.

THE MARSEILLES-RHONE CANAL

(*For description see page* 432)

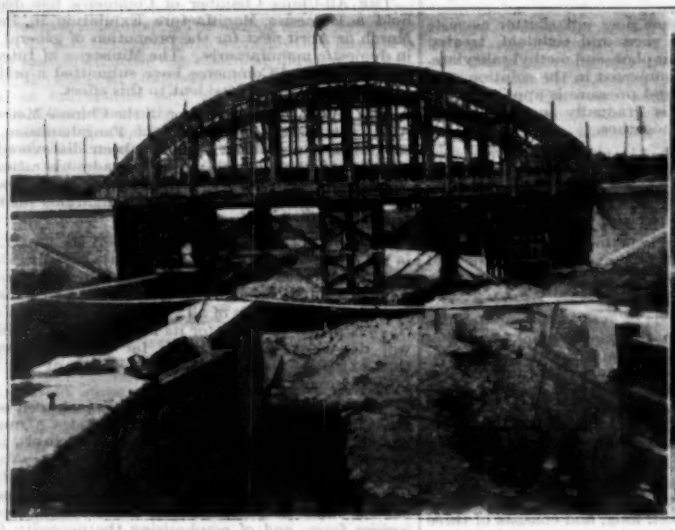


FIG. 6—CONCRETE BRIDGE AT PORT DE BOUC UNDER CONSTRUCTION

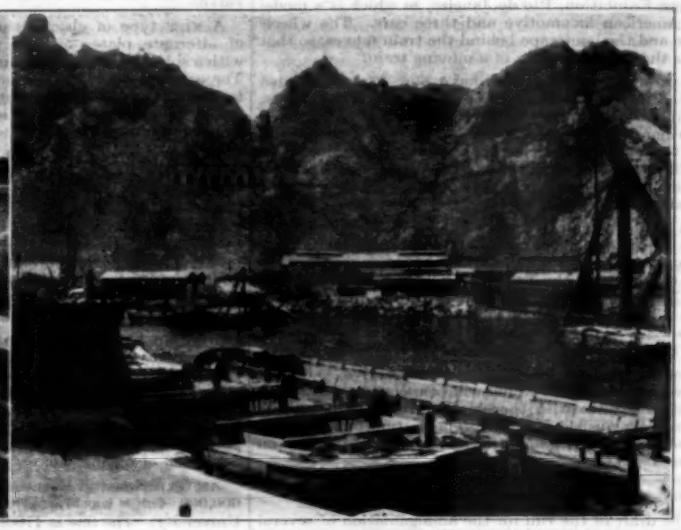


FIG. 7—ENTRANCE TO TUNNEL UNDER THE NERTHE MOUNTAINS

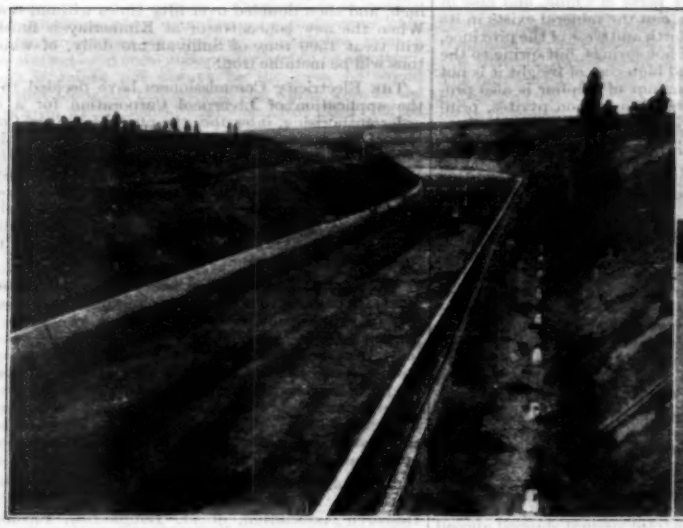


FIG. 8—THE CANAL NEAR PORT DE BOUC

FIG. 9—DISCHARGING MATERIAL EXCAVATED FROM THE ROVE TUNNEL

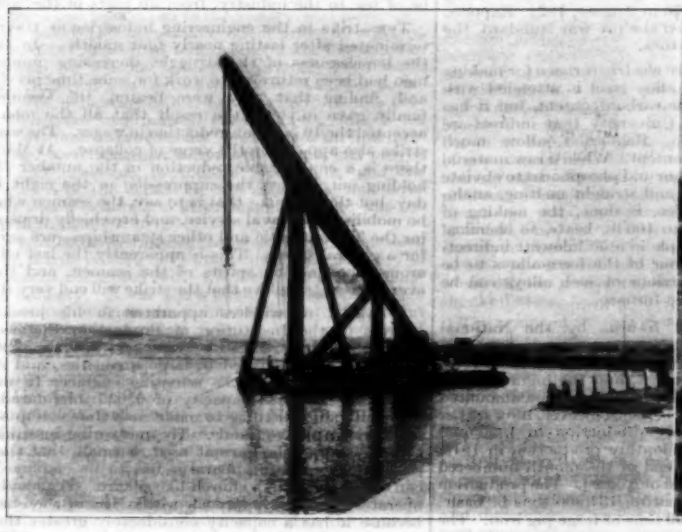


FIG. 10—CRANE FOR HANDLING 50-TON BLOCKS FOR BREAKWATER

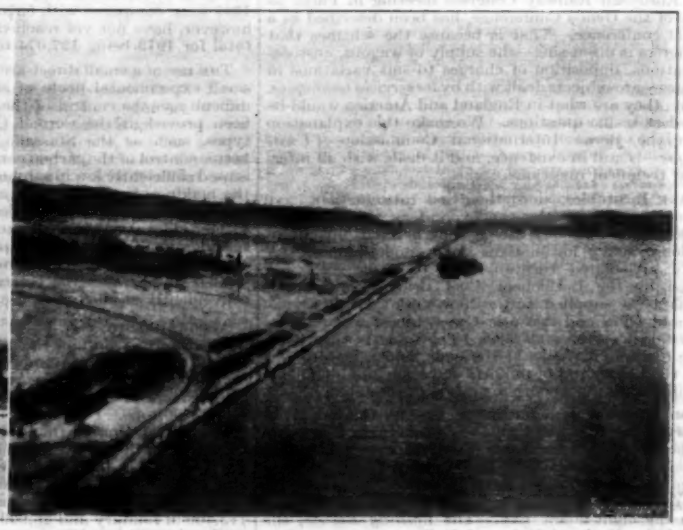


FIG. 11—VIEW ALONG NORTH SIDE OF THE ETANG DE CARONTE

AGENTS ABROAD FOR THE SALE OF

The Engineer

BUENOS AIRES.—Mitchell's Book Store, 576, Cangallo.
CHINA.—Kelly and Walsh, Limited, Shanghai and Hong Kong.
EGYPT.—Cairo Express Agency, near Shepheard's Hotel, Cairo.
FRANCE.—Boyveau and Chevillet, Rue de la Banque, Paris. Chapelot and Cie., 136, Bld. St. Germain, Paris.
BELGIUM.—W. H. Smith and Son, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.
INDIA.—A. I. Combridge and Co., Bombay; Thacker and Co., Limited, Bombay; Thacker, Spink and Co., Calcutta.
ITALY.—Maglioni and Strini, 307, Corso, Rome; Fratelli Treves, Corso Umbarto 1, 174, Rome; Fratelli Bocca, Rome; Ulrico Hoepli, Milan.
JAPAN.—Maruzen Co., Tokyo and Yokohama.
AFRICA.—Wm. Dawson and Sons, Limited, 7, Sea-street (Box 49), Capetown.
C. Juta and Co., Johannesburg, East London, and Grahamstown.
AUSTRALIA.—Gordon and Gotch, Limited, Melbourne, Sydney, Brisbane, and Perth, &c.
Melville and Mullen, Melbourne.
Atkinson and Co., Gresham-street, Adelaide.
CANADA.—Dawson, Wm., and Sons, Limited, 87, Queen-street East, Toronto.
Gordon and Gotch, Limited, 132, Bay-street, Toronto.
Montreal News Co., 386-388, St. James-street, Montreal.
Toronto News Co., 42, Yonge-street, Toronto.
CEYLON.—Wijayaratna and Co., Colombo.
JAMAICA.—Educational Supply Co., Kingston.
NEW ZEALAND.—Gordon and Gotch, Limited, Wellington and Christchurch; Upton and Co., Auckland; J. Wilson Craig and Co., Napier.
STRAITS SETTLEMENTS.—Kelly and Walsh, Limited. Singapore.
UNITED STATES OF AMERICA.—International News Co., 83 and 85, Duane-street, New York; Subscription News Co., Chicago.

Agents Abroad for Advertisements.

UNITED STATES OF AMERICA.—British and Colonial Press, Inc., 736, The Knickerbocker Building, 152, West 42nd-street, New York City.
FRANCE.—Agence Vox, 7, Rue de Surène, Paris (VIIIe).
BELGIUM.—W. H. Smith and Son, 78/80, Rue du Marché-aux-Herbes, Bruxelles, and 44, Rue Joseph II., Ostend.

SOUTH AMERICAN BRANCH OFFICE OF

The Engineer,

526, Bolsa de Comercio, Buenos Aires

SUBSCRIPTIONS.

The Engineer can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.
Half-yearly (including index number) .. £1 12s. 6d.
Yearly (including two index numbers) .. £3 5s. 0d.
If credit occur, an extra charge of two shillings and sixpence per annum will be made.

Foreign Subscriptions will be received at the rates given below. Foreign subscribers paying in advance at these rates will receive The Engineer weekly and post free. Subscriptions sent by Post Office Order must be made payable to The Engineer and accompanied by letter of advice to the Publisher.

Thin Paper Copies.		Thick Paper Copies.	
Half-yearly	£1 11s. 6d.	Half-yearly	£1 13s. 0d.
Yearly	£3 5s. 0d.	Yearly	£3 7s. 6d.

(The difference to cover extra postage.)

Canadian Subscriptions—
Thin paper edition .. .. £2 18s. 6d. per annum
Thick paper edition .. .. £3 3s. 0d. "

*** Reading Cases, *to hold two copies of* The Engineer, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

ADVERTISEMENTS.

*** The charge for Situations Open and Wanted Advertisements of four lines and under is four shillings, and one shilling per line for each additional line up to one inch. When an advertisement measures an inch or more, the charge is twelve shillings per inch. The rates for all other classes of advertisements, other than those mentioned above, are included in "The Engineer Directory," which is sent post free on application. All single advertisements from the country must be accompanied by a remittance in payment. Alternate advertisements will be inserted with all practical regularity, but regularity cannot be guaranteed in any such case. All except weekly advertisements are taken subject to this condition.

Small Advertisements cannot be inserted unless delivered before TWO o'clock on Thursday afternoon (the day before publication). ALTERATIONS to STANDING ADVERTISEMENTS must arrive not later than THURSDAY of the week preceding publication.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Manager, all other letters to be addressed to the Editor of The Engineer.

Postal Address, 33, Norfolk-street, Strand, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Telephone Nos. 2256, 2257 Central.

PUBLISHER'S NOTICES.

*** *If any Subscriber abroad should receive* The Engineer *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

TO CORRESPONDENTS.

*** *All letters intended for insertion in* The Engineer *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

By arrangement with Reuter's Engineering Service, **The Engineer** *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

	PAGE
The Engineer, October 27th, 1922.	
The Gaseous Fluid Ejector. No. II. (Illus.)	429
Simon Goodrich and His Work as an Engineer. Part I.: 1766–1805	431
Marseilles-Rhone Canal. (Illus.)	432
Institution of Mechanical Engineers	434
Lloyd's Register—Annual Report	436
A Seven-Day Journal	437
Chinese Engineering Notes. (Illus.)	438
Water Power in Argentina	439
The Physicist and the Electrical Engineering Industry	440
Railway Matters	441
Notes and Memoranda	441
Miscellanea	441
Leading Articles—	
Vague Specifications	443
Hours and Output	443
Wave Transmission of Power. No. I. (Illus.)	444
Tests of Drainage and Subsoiling Machines	445
Progress in Liquid Fuels	446
The Care and Maintenance of Diesel Engines. (Illus.)	447
Letters to the Editor—	
Local Electricity Supply v. Bulk Supply	448
Japanese Trade	449
The Student in the Factory	449
Railway Bridges	449
The George Richards' Fund	449
Strengthening New Holland Railway Pier. (Illus.)	450
The Preservation of Iron and Steel	450
Provincial Letters—	
The Midlands and Staffordshire	451
Lancashire	451
Sheffield	452
North of England	452
Scotland	453
Wales and Adjoining Counties	453
Launches and Trial Trips	453
Personal and Business Announcements	453
Current Prices for Metals and Fuels	454
French Engineering Notes	455
British Patent Specifications. (Illus.)	455
Forthcoming Engagements	456
Paragraphs—The Institution of Automobile Engineers—The Institute of Marine Engineers—Contracts—The Institute of Cost and Works Accountants—A New Steam Trap—The Optical Society	440
Institution of Production Engineers	456

THE ENGINEER.

OCTOBER 27, 1922.

Vague Specifications.

No one can at the present time doubt the very great value of the work done by the British Engineering Standards Association in the improvement of specifications for engineering materials. By bringing together well-informed representatives of both makers and users of such materials, the Association, through its numerous sub-committees and panels, generally succeeds in arriving at some sort of compromise between the opposing interests concerned, with the result that valuable progress is made. It is true that there are at times cases of unreasonable attitude on both sides of such questions. At times the user seeks to impose demands which would unduly hamper the manufacturer, and at others—rather more frequent—the manufacturer seeks to depress what he terms the severity of the specification, in what, he believes, to be his own interest, in the hope of reducing the cost of manufacture. Occasionally these efforts succeed in reducing the standard demanded of a given material, and that result may appear to be helpful to the manufacturer. Frequently, however, the resulting disadvantages recoil on his own head, especially in the case of rather high-priced products. If the demands which the user may make on such materials are reduced, then it often happens that the designer reverts to cheaper materials which—cost for cost—do not prove ultimately more expensive.

However it may be arrived at, and whatever the compromise adopted in any given case, the harm which is liable to result cannot be very serious, provided that the specification is clearly drawn and that it is consistent with technical and scientific fact. That users and manufacturers alone cannot always arrive unaided at a specification fulfilling these demands has come to be recognised, with the result that the scientific and technical expert is now more or less adequately represented on all, or nearly all, the standardising committees. An exception still exists in regard to certain of the older committees which were constituted at a time when the value of scientific knowledge, particularly on metallurgical matters, was not so fully appreciated. Some of the older specifications exhibit very markedly the effects of the lack of adequate metallurgical guidance, and they show it in this particular matter of vagueness. We may take as an example the specification of definite temperature ranges for heat treatment. We do not suggest that, for the majority of purposes, these figures require to be specified to any alarming degree of accuracy. In the majority of cases ranges as wide as 20 deg. or even 30 deg. Cent. are permissible, provided that such a range is located at the proper part of the temperature scale. It is just this location of the correct range which demands scientific control. There is, even to-day, some reluctance to employ the reliable modern methods of pyrometry, and in the absence of men who are familiar with the ease of application of such methods at the present time, specifications are apt to be drawn with references to temperatures put in so vague a manner as to be useless or worse. An interesting example has recently come under our notice in connection with the so-called "temper bend" test applied to certain qualities of mild steel plates. It is specified that the steel, after heating to and quenching from a certain temperature shall withstand a specified amount of cold bending without cracking. It is difficult to conceive that such a test has been imposed for any other purpose than that of showing whether the steel is soft or "mild" enough to be free from serious hardening if it should be heated and rapidly cooled during manufacture or construction. It seems doubtful whether, at its best, such a test can give any information which a competent metallurgist cannot at once infer from the combined content of carbon and manganese given by the chemical analysis. If such a test is thought necessary at all, however, it is surely essential that the temperature to which the test piece is to be heated, and from which it is to be quenched shall be high enough to cause hardening if the steel is of such a quality as to be capable of appreciable quench-hardening. Actually, in the specifications in question, the temperature is merely specified as a "blood red." The occurrence of so vague a term in any important specification is surprising in the present state of our knowledge of the metallurgy of steel; actually, it renders the whole of the tests in question entirely valueless. The interpretation put on the term "blood red" depends enormously on the individual who is called upon to apply it, and the tendency, in the case of a specification test, will inevitably be to make the test as lenient as possible—in this case, by using the lowest possible temperature. Actually, it is found that a highly skilled and experienced inspector interprets the temperature in question at anything from 630 deg. to 670 deg. Cent. Now it is obvious that quenching from such a temperature is entirely useless for the purpose of determining whether the steel is mild enough to be free from the danger of being hardened by accidental quenching. No ordinary carbon steel, however hard and, for the purpose in question, dangerous it might be, would show any hardening effect when quenched from a temperature below the critical range—740 deg. to 750 deg. Cent.—in fact, the effect of heating a steel to such a temperature as 650 deg. Cent., even when followed by quenching, is to soften rather than to harden it.

While, perhaps, no very great importance need be attached to the "temper bend" test of mild steel plates, we have quoted it as an example of vagueness in specifications. Fortunately, such examples are rare, and, it may probably be claimed, are entirely absent in the more recent specifications of the British Engineering Standards Association, which have been drawn up by panels and committees well provided with scientific metallurgical assistance. Where older specifications exist which have been drawn up without such aid, it is important that revision should take place. Before such revision can be made effective, however, it is essential that the committees which have to deal with it should be brought up to date. There is, at the present time, no need and indeed no excuse for vagueness of this kind. Nor need the manufacturer fear that the specifications are likely to be subtly stiffened; it can only be in the best interest of manufacturer as well as user to have specifications perfectly clear and definite—not necessarily hard and fast, but with latitude well and clearly defined wherever the conditions of manufacture and test make latitude necessary and desirable.

Hours and Output.

We have already given long extracts from the report of the Joint Investigation Committee composed of six representatives of employers and six of labour, appointed by the Engineering and National Employers' Federation, the Shipbuilding Employers' Federation, and the Unions' Negotiating Committee. Those extracts dealt only with the conditions that were found to exist in England and Scotland, and there remains a large portion of the report—of which we hope to give an abstract at an early date—which records the experiences of shipbuilders and engineers in Belgium and Holland and Germany. In a general way we do not think it wise to draw comparisons between different nations. Even when setting-up purely scientific

contrasts it is frequently well nigh impossible to make certain that only one variable has been changed; that secondary influences of which the effect is uncertain have not come into play. In comparing different nationalities the task is infinitely more difficult, because a great number of variables always exist, and we can rarely or never be sure that we are picking out for study those two that are strictly comparable Things that may be done in France, Belgium, Germany or America may be impossible in the United Kingdom, not only because racial traits differ, but because a certain aspect of mind has been developed in the peoples during the progress of the generations, and because certain traditional practices have vitrified into permanence For these reasons, we think, in a general sense, it is best for each nation to settle its own affairs in its own way, and not to seek to graft a foreign scion on to its ancient stock. To take a familiar example, it seems to us unwise to stress greatly the great difference in the relationship of mechanical horse-power to workers in America and Great Britain. The conditions in the United States make a high consumption of horse-power both necessary and possible; here we have so far succeeded very well with a lower consumption because conditions are different. In China and India a still lower quantity has been ample.

Whilst, then, we exercise great caution in contrasting foreign workshop economics with British, we think in this case it is safe to do so, because, in fact, we need not compare Belgium or Germany with Great Britain, but can compare each country with itself under a set of conditions which are nearly common to all nations. We have seen, to take a case in point, that when the working hours in England were reduced from fifty-four to forty-seven the drop in output was directly in proportion to the loss of time. That was a result contrary to the anticipation of many economists. Let us see what happened in France and Belgium. If similar effects followed we must exonerate the British workmen from any particular and national badness in this respect; if they are different, then another deduction must be made. We turn to the report. The working hours in most shops in Belgium used to be fifty-five to sixty per week; they are now forty-eight—that is to say, they have been reduced by between about twelve and twenty per cent. In an interview the Belgian Minister of Labour, when specifically asked if there had been an increase or a decrease in output per hour, stated that the position varied very much from factory to factory. But such figures as he gave seemed to indicate that if there was any increase to make up for the reduction of hours its incidence must have been very rare. He stated furthermore "that the evidence in his possession showed a greater decrease in output in the case of the timeworkers than in the case of pieceworkers, but in all cases there had been a diminution all round in output per hour." The Dutch Permanent Under-Secretary for Labour reported, as a special case, that "when the hours in textile works were reduced from eleven to ten the result was an increase in output per hour, but the further reduction from ten to eight had not had the same result." In Germany the Committee found that the output had been reduced in proportion to the reduction in hours—from fifty-four to forty-eight. It will be seen from these few observations that we have a constant condition in labour circles—reduce the hours of work and the output will diminish proportionately. This law, if we like to honour it with the title, may be put in another and more useful form. "The average output per hour per worker is a constant." Thus the theory of those who hold that because men worked fewer hours they would get less tired and stale and would, therefore, produce as much as they did in longer hours, is exploded with its fellow theory that the efficiency before breakfast was very low. It is the "before-breakfast" hour that has gone, and the output has dropped in direct proportion to its loss; hence we must conclude that it was of equal value with other hours. We are not here concerned with the causes that result in a constant rate of output per hour. To discuss them would lead us into the region of uncertainties. In one country the output may be constant because the people have always worked "all out"; in another ca-canny may be an established policy; in a third the factory equipment may be the controlling element. The only fact that is of direct use to us is that, *pace* all the arguments of economists and psychologists, workpeople in Europe, and probably the world over, have—each nation for itself—a nearly fixed rate of output per hour, and that if we reduce the hours we shall reduce the output in nearly direct proportion.

The conclusion to which we have been led by these considerations might be followed by the deduction that the industries of Great Britain are in a serious position. We have reduced the working week by twelve and a half per cent. and the reduction of output is nearly in proportion. The wages for the shorter week are higher than they were for the long one, and the final issue is that all productions are more costly, so costly that purchasers are hard to find and competitors make way against us. Fortunately, there is a way out of the bad position. There is a very large margin between what a man can do and what he does do in the engineering trades. No doubt at all exists that with sufficient inducement fifty per cent. increase can be secured in many cases and thirty per cent. in all. The solution of the problem with which we are industrially faced is the general adoption of payment by results, whether in the form of straight piecework, premium bonus, or bonus on mass output. Employers gave way, against their convictions, on the matter of hours; they have a right to insist, now that it has been shown that the short week output is less than the long week output, that they shall be allowed to adopt methods of payment that will, at the very least, restore the balance.

Wave Transmission of Power.

No. I.

It cannot be denied that the system of transmission of power by means of hydraulic waves, associated with the name of Mr. George Constantinesco, is a matter of scepticism or of entire disbelief in certain engineering quarters. Of the adverse opinions expressed concerning it, we need here repeat only the most charitable one, to wit, that Mr. Constantinesco is entirely mistaken in his theories, that the results obtained or claimed to be obtained do not depend upon the generation of waves in the transmitting fluid, and that the whole thing is nothing more nor less than the transmission of power and movement by ordinary hydraulic pressure. To this criticism is frequently added the view that even though wave transmission were at the basis of the matter as is alleged, it would possess no advantage in practice over ordinary hydraulic transmission.

We have not had the pleasure of meeting Mr. Constantinesco, but having made a close inspection of some of the products of his genius, we have no hesitation in saying that this criticism is both ill-founded and short sighted, even although, as we are well aware, some support to such criticism may have been lent by certain guarded views on the fundamentals of the system previously expressed in these columns.

The genesis of the invention, so far as we have been able to investigate it, was laid in Roumania by Mr. Constantinesco, sen., a keen mathematician, who devoted a large part of his life to a study of the scientific side of musical theory. His son, Mr. George Constantinesco, combined his father's love of music and physics with the study of engineering, and in the course of his investigations arrived at the conclusion that of all musical instruments, the common trombone was probably the most efficient from the point of view of the energy put into it and the energy represented by the volume of sound which it produces. With the imagination of the true inventor and his experience as an engineer, he began speculating as to the possibility of reversing the process, and transmitting power by substantially musical means. There is nothing musical—far otherwise indeed—in the operation of the rock drill which to-day represents one—only one—practical application of Mr. Constantinesco's fundamental idea. Nevertheless, there is primitive truth in a wit's remark that the system aims at driving a motor car by playing Tchaikowski's "1812" overture at the end of a pipe.

Mr. Constantinesco proceeded to develop his idea experimentally and mathematically, and after bringing it to a practical basis, came to England some time before the outbreak of the war. Subsequently, he succeeded in arousing interest in the invention in Mr. Walter Haddon, of W. H. Dorman and Co., Limited, of Stafford, and an experimental establishment was set going at Alperton, near Ealing. With the outbreak of war his thoughts naturally turned to the military applications of his invention. His chief contribution in this respect was a highly important item in the factors which led to our aerial supremacy, namely, the "C.C." interrupter gear, which enabled the problem of firing from a machine gun through the propeller of an aeroplane to be satisfactorily solved.

It is not our purpose to describe the interrupter gear in detail, but as it throws some light on at least one important aspect of wave transmission, we may pause for a moment to consider its general principle. It consisted, as some readers may already know, of a cam on the propeller shaft, which drove a plunger in a small cylinder, from which a pipe led the wave impetus generated by the rapid reciprocation of the plunger through a very small range, to a trigger release gear. Its action was such that when the pilot exerted a continuous pull on a control lever, the trigger release gear was automatically operated, so as to permit the gun to fire only when the propeller blades were clear of the muzzle. The gear would have made it possible to fire at the rate of 3000 bullets a minute, but the gun limited the number of rounds fired to 600 or so per minute in the early days of the war and to about 1200 towards the end. Hence it will be seen that the gear did not in any way restrict the rate of firing of the gun. It only checked it at the times at which, if fired, the bullet would have struck the propeller blade.

Several questions of general importance may here be answered. In the first place, why was it necessary to use a hydraulic system of control rather than a straightforward purely mechanical one? The answer is that of all the many mechanical interrupter gears tried during the war, none showed the same complete independence from the disconcerting effect produced by the bending and flexure of the aeroplane structure or of the parts of the control gear itself. With a purely mechanical gear, a rapid turn or dive of the aeroplane would so bend the fuselage structure and distort the connecting links between the propeller shaft and the control gear at the gun trigger as to upset completely the synchronism between the release of the trigger and the passage of the propeller gaps across the muzzle. In the "C.C." gear the connecting member was a tube containing liquid. Its distortion was without effect on the synchronisation.

Secondly, granted that a hydraulic system of control was desirable, why was it necessary to rely on a wave transmission system rather than one using ordinary hydraulic pressure? The answer to this question is of fundamental importance, for it applies to all other applications of wave transmission. The simple fact is that if a column of water, even of the short length involved in the "C.C." gear, had to be moved bodily backwards and forwards through 3000 complete cycles per minute, the inertia would result, as can readily be shown by calculation, in the generation of prohibitively great and possibly destructive pressures. With wave transmission, the same magnitude of movement can be produced without reasonable pressures being exceeded.

Thirdly, it may be asked whether the transmission of the wave impulses can be relied upon to be sufficiently rapid or to occupy a sufficiently uniform interval of time between generation at the propeller shaft and receipt at the trigger control to permit the system to be employed without fear of its getting out of step at some time or other. The answer is sufficiently clearly expressed without farther labouring the point in the fact that the "C.C." gear was regularly used as a means of testing the standard of small arms ammunition and in at least one instance led to a large consignment being rejected. In other words, if it were found that the bullets were striking the propeller blades, the assumption was not that the interrupter gear was wrong, but that the ammunition was defective.

The success of the gun gear cannot be doubted. It led eventually to the Alperton establishment being taken over by the Admiralty and to Mr. Constantinesco's being officially employed to conduct research work on farther service applications of his principle. What exactly these applications were it is perhaps desirable not to mention, for we are not aware how far they are still regarded as secrets. It may be said, however, that had the war lasted a little longer some of them would have been brought into regular use. As it was, they were left in suspense when in some cases as much as 90 per cent. completed. In this work there was laid the foundation of a very important and interesting branch of the subject, namely, the application of wave transmission to the production of rotary motion. Quite recently, this branch has been taken up again, and it is probable that it will be possible in the not distant future to say more about it.

After the war, an arrangement was come to whereby Mr. Haddon became possessor of the patent rights for wave transmission in the British Isles and Dominions, while Mr. Constantinesco took those for the Continent. Mr. Haddon is thus now the sole owner of the patents so far as this country is concerned. So far as the application of the principle of wave transmission to rock drills and other percussive tools is concerned, technical development in the immediate past and in the future has been and will be in the hands of Messrs. Dorman at Stafford. On the other hand, the technical development of the principle in its application to the production of rotary motion has been placed by Mr. Haddon under the charge of Mr. Walter N. Duff, of London, who as an engineer was brought into intimate contact with Mr. Constantinesco's later developments during the war.

In connection with the items of historical interest which we have mentioned, it seems desirable to state that they are correct so far as we are able to say, but that as they have not been confirmed by the principal person concerned, they may possibly in some minor respects be open to emendation.

It is probably no more possible fully to understand the Constantinesco wave transmission system without recourse to mathematics than it is to study alternating-current theory on a non-mathematical basis, a theory to which that underlying wave transmission bears an extraordinary and obviously not wholly fortuitous resemblance. The mathematical side of the subject has, however, been fully covered already by Mr.

Constantinesco himself, so that for the present we do not propose to go into it.

So far as the theory of the subject is concerned, the most important fact to note from the practical point of view is that whereas in ordinary hydraulic transmission the water used behaves, or may be regarded as behaving, as an incompressible fluid, in the Constantinesco wave transmission system its compressibility is the basis on which the whole action is founded. The compressibility of water, like that of other liquids, depends upon its temperature and the general pressure to which it is subjected. From the practical standpoint, however, so far at least as wave transmission is concerned, its variation with these factors may be neglected. In particular, any variation of compressibility produced by a change of atmospheric temperature between the extremes of the range experienced in this country has a negligible influence on the results obtained. Of much more practical importance is the influence on the compressibility figure of the air dissolved in the water, although even in this respect any difference of a normal amount is without great effect on the working of a wave transmission system.

The exact degree to which water is compressible is variously reported. It is, however, a sufficient indication for our present purpose to say that a cubic foot of water weighing 62.4 lb. will, when subjected to a pressure of 1000 lb. per square inch, change in volume to 0.9968 cubic foot, and that 1 cubic foot at such pressure will weigh 62.6 lb. The coefficient of volume elasticity indicated by these figures is 44,000,000, so that in accordance with the formula $V = \sqrt{(k\,g/\rho)}$, the velocity of sound in water is 4800ft. approximately per second, or nearly 4½ times as great as in air.

Let us imagine that we have a cylinder—Fig. 1—filled with water and closed at one end by a resiliently mounted piston A, and at the other by a piston B, which can be reciprocated by power. If the piston B be moved slowly the piston A will reciprocate in unison with it, for the intervening water will act simply as a connecting-rod. The pressure in the water will rise and fall through a certain range during the reciprocation, but at any one instant it will be uniform throughout the whole mass. Such uniformity of pressure distribution is characteristic of ordinary slow-speed hydraulic transmission.

Let, now, the speed of reciprocation of the piston B be considerably increased. The conditions become completely altered, for the inertia of the water produces an effect which dominates the situation, an effect which results in the pressure in the water being no longer instantaneously uniform throughout the mass, but varying in a manner expressed by a sine curve. Such varying pressure is characteristic of the Constantinesco wave transmission system.

The inertia effect is, of course, in existence at all speeds, however low, but it is only when the speed of reciprocation is high that it is other than negligible. There are many instances of a similar kind which are familiar to engineers. The indicator rig for a slow-speed engine may make use of a cord connection to the indicator drum. On a high-speed engine, such a rig would introduce serious errors as a result of the periodic stretching and recovery of the cord under the influence of the inertia of the indicator drum. A shell designed to be fired by a charge of cordite would, under the much quicker action of a high explosive charge, collapse or set up as a result of the resistance which its inertia opposes to its being set in motion.

We do not propose to attempt the very difficult and tedious task of explaining without the aid of mathematics how the waves of pressure and rarefaction are set up in the water when the piston B is reciprocated rapidly. Suffice it to say, that as in an organ pipe, the theory of which may be studied in any text-book on sound, the alternate acceleration and deceleration of the piston B, in conjunction with the inertia of the water and the momentum communicated to it, result in the water at any one section being caused to pass through a cycle of compression and rarefaction. The different sections at any one instant are at different stages of their cycles, with the result that at any given time a curve drawn to represent the pressure in the water would have a sinusoidal form. On reaching the piston A the wave is reflected back towards B, the pressures of the reflected wave, independently considered, again being representable by a sine curve. The actual state existing inside the pipe at any instant is found by combining the two curves. As is well known, the combination results in the pressure at the points C D, one-quarter and three-quarters respectively along the length of the pipe, remaining constant at all times, while at the middle and at the two ends the pressure and rarefaction fluctuations attain a maximum value.

Two points of practical importance may here be noted. In the first place, as a means of transmitting power, the arrangement would be completely non-effective if the power-receiving device—say, a rock drill—were attached at either of the nodal points C D, for at these points there is no fluctuation of pressure. On the other hand, the device might equally well be attached either at the middle or at the end of the pipe line, for at these points there is equal fluctuation of pressure. This fact distinguishes wave transmission from ordinary hydraulic transmission, which, of course, works equally well with any length of pipe. In an instance which we recently had an opportunity of examining, the speed n of the crank driving the generator piston B was 2400 revolutions per minute. If V be the velocity of sound in water in feet per second, then the wave length is given by $60\,V/n$. Taking V at 4800ft. per second, the wave length in this instance was 120ft. The length of pipe between the generator B and a rock drill attached to it was 60ft.—that is, half the wave length—and consequently the drill worked satisfactorily. At our special request, the length was then decreased to 30ft. or quarter the wave length. In this condition, when the control valve was opened, the drill completely refused to work, demonstrating clearly that it was attached at a node at which there was no fluctuation of pressure.

In the second place, it is to be noted that the degree of rarefaction suffered by the water is theoretically equal to the degree of compression. In order, therefore, that the full possible rarefaction may be developed, it is necessary to apply to the water an initial constant steady pressure at least equal to the maximum increase of pressure produced by the compression. The rarefaction will then be realised without lowering the water below atmospheric pressure.

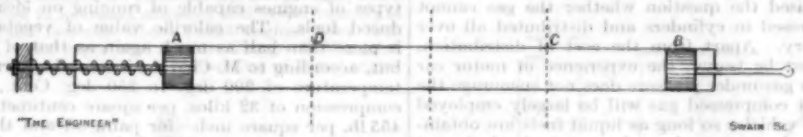


FIG. 1

Tests of Drainage and Subsoiling Machines.

We were invited by the Ministry of Agriculture and Fisheries to be present on Tuesday last at a demonstration of land drainage and subsoiling machines in operation. The demonstration, which had been organised by the Ministry, acting in conjunction with the Kent Agricultural Education Committee and the Kent Branch of the National Farmers' Union, took place on the farm of Mr. F. O. Streeton, of High Hilden, about 1½ miles north of Tonbridge, and extended over Tuesday and Wednesday of this week. The purpose of the demonstration was to give publicity to the steps which are being taken by the Ministry for the purpose of collecting reliable information regarding the cost and utility of farm draining and subsoiling by mechanical means, and to afford to farmers an opportunity of seeing machines under actual working conditions. The tests, which were in part witnessed at the demonstration, form a sequel to and are intended to complete, in certain respects, a series of investigations which have been in progress during the past eighteen months or so, with the object of enabling the Ministry to put itself in a position to assist agriculturalists in every possible manner, the ultimate object being that it shall be able, when it is supplied with particulars of any given land, to advise a farmer how best to cultivate it. The question is not only being investigated by such means as that illustrated by the present trials, but different branches of it are being entrusted to various institutions specially devoted to the study of agricultural matters and to University departments, so that the results arrived at may have the widest possible basis.

For the moment, however, we are not so much concerned with the wider activities of the Ministry as with the actual trials of this week. The devices taking part in the demonstration may be divided into three main groups, covering the following operations:

(1) Ditch and pond cleaning, loading farmyard manure, &c.;
(2) Mole draining; and
(3) Subsoiling.

Under the first heading, all that we saw was a Priestman bucket grab and jib crane carried on a Clayton chain track tractor, which was engaged in excavating clay from a small pond. We believe that it was intended on the following day to employ it on clearing a portion of the Hilden Brook, which traverses a portion of the demonstration site, and would certainly be the better for a thorough cleaning out. As we saw the machine, however, it was only getting muck in small quantities out of a quite small pond—a not particularly convincing operation. It was a portion of the proceedings which, as far as what was going on on the occasion of our visit was concerned, might well have been omitted.

Mechanical mole draining, on the other hand, was being carried out under actual service conditions, and was distinctly interesting. First of all, there were two cable sets. One was made by Fowlers, of Leeds, and was operated by two of that firm's steam ploughing engines. It appeared to be doing its work most efficiently. The other was made by Messrs. F. B. Wells and Son, of Burleigh Welwyn, Herts., and it, too, was working well, though it certainly was not keeping such straight lines as was the Fowler equipment, and why it should be operated by two foreign—Borsig—internal combustion engines in a demonstration made in England, it was rather hard to see. It is true that during the war, when it was of the utmost importance to increase by all possible means the amount of home-grown foodstuffs, the Ministry purchased many thousands of foreign tractors of various kinds, but it seems unlikely, to say the least of it, that, among the machines so acquired, were hauling engines of Austrian origin. That, however, is by the way; the engines were doing their work, and, from what we understood, doing it economically.

In addition to the cable sets there were two mole drainers which were in operation, being hauled by internal combustion tractors. One was a self-lift mole plough made by Martin's Cultivator Company, Limited, of Stamford, and the other a mole drainer made by F. B. Wells and Sons, and similar to that being worked by cable and alluded to above. Of both, it can be said that apparently they were doing their work satisfactorily.

There was also on view a Buckeye tractor ditcher, the proposed duty of which was to cut the main drains for the field in which the mole drains were being formed by cable haulage. It was not, however, in operation at the time of our visit, but it had previously cut a short length of deep and narrow ditch in excellent fashion.

In another position on the site, somewhat extensive operations were being carried out with the object of investigating the question of "subsoiling," or the breaking up of the hard pan which forms in clayey lands as the result of years of cultivation. There are two methods in vogue for performing this operation, namely:—

(*a*) Inverting the pan to the surface, and
(*b*) Disturbing or disrupting the pan without inverting it to the surface.

Authorities are not in agreement as to which, under all circumstances, is the correct system to employ, and with a view to obtaining first-hand information on the subject, the Ministry proposes to take advantage of the present opportunity to make special observations in a thoroughly scientific manner. Various plots of similar land will be treated by different methods, and careful observations made as to the behaviour of identical crops under the varying conditions. It intends also to determine whether subsoiling does actually increase the produce of the crops, and also the cheapest and best methods of securing the best results. In carrying out its project the Ministry is proposing to determine the actual cost of performing the operation of subsoiling by all known methods, the final criterion being the measured yield of the plots under observation. It will also inquire into the factors that enter into the design of the different patterns of subsoilers in order that the data so obtained may be of value in indicating what form of design best disrupts the pan with a low consumption of power. Observations will also be taken regarding the influence of subsoiling on the physical state and chemical contents of the soil, such factors as moisture, temperature and manurial value being taken into consideration.

Among the implements submitted for test during the present investigations were a Ransome self-lift subsoiling and drainage tractor plough, fitted with a digging body and a subsoiling tine; a Ransome two-furrow self-lift tractor plough, fitted with a general purpose body and a subsoiling tine in front of the ploughing body; a Ransome subsoiling attachment fitted to a 2–3 horse general purpose plough; a tractor subsoiler made by Celliers Motors, Limited, of Coulsdon, operated by a Fordson tractor; a Hornsby single-furrow self-lift deep-digging tractor plough, with a detachable subsoiler; a Hornsby two-furrow tractor plough, with the front body removed and replaced by a subsoiling tine; and a "Darby" subsoiling conversion set made by Mr. Darby, of Wickford, in Kent. It was noticeable that several of the tractors employed were of American manufacture. Why this should have been so, unless it was the result of the purchase of tractors by the Ministry, mentioned above, we cannot say.

Considerable developments are reported in *Indian Engineering* in connection with the utilisation of electric power in Upper India. The Indian Electric Supply and Traction Company, Limited, Cawnpore, whose fine new power-house on the banks of the Ganges at Cawnpore is being set to work, has found it already necessary to extend. In addition to the two 4500 horse-power steam turbine generators now being started, this company is now ordering two 9000 horse-power generating sets and the necessary boiler and electrical equipment. This power-house is the largest and most up-to-date in Upper India.

Progress in Liquid Fuels.

So vast is the problem of liquid fuels that close upon one hundred communications, some of them of a particularly important character, were presented at the International Congress organised by the Société de Chimie Industrielle, and held recently in a temporary exhibition building erected on the Esplanade des Invalides, Paris. Nearly all countries interested in the question were officially represented. The Congress was presided over by Professor Paul Sabatier, Doyen of the Faculty of Sciences at Toulouse, whose catalytic process for the dissociation of molecules in liquids has opened up an apparently inexhaustible field for the production of light oils for motor fuels. The Congress was divided into six sections, devoted to petroleum, schist oils, lignite and peat, tars and benzol, alcohol, and vegetable oils. One of its objects was to fix upon a standard nomenclature for petroleum products and definite systems of analyses, whereby it would be possible for importers and consumers to know exactly what they were selling and using. In view of previous failures to arrive at an international standard, it was soon made clear that the difficulties at present were practically insuperable, and it was decided that the only solution was for each country to appoint a commission to draw up an exact list of the names of petroleum products, and the French commission, which is working in collaboration with a committee already existing at the Ministry of Commerce, will prepare a table in which each product will be classified under its foreign names.

The present situation of liquid fuels was admirably summarised by Professor Daniel Berthelot, who, as President of the Comité Scientifique du Carburant National, has taken an active part in the recent researches for fuels capable of replacing or of being used in conjunction with petrol. The question is not a new one, for it dates back to 1897, when the Ribot Commission published a particularly exhaustive report upon the utilisation of alcohol as a fuel. The seriousness of the situation, however, only became manifest during the war, and it has been aggravated since then by the enormously increasing consumption of petroleum oils for marine engines and of petrol for motor cars and aeroplanes, to the extent that at the present rate of increase the whole of the existing supplies of petroleum will be exhausted within sixty years, while long before that time the quantities available will be so far limited that it will be impossible to rely upon them. For the moment there can be no question of diminishing the quantities of petroleum necessary for marine engines and of petrol for aviation; but it is possible to economise petrol for motors and for other uses by mixing it with other hydrocarbons, and eventually there is every prospect of petrol being superseded by synthetic spirit produced from vegetable oils by means of the catalytic process. The mixing of petrol with other hydrocarbons is regarded as a transition stage, until such time as science and industry are able to utilise the solar energy which is being stored daily in vegetable products, and will therefore provide abundant and inexhaustible supplies of fuel.

The hydrogenation process of Bergius has opened up a wide field of experiment and research in the way of producing light oils direct from petroleum by-products and other fuels of low commercial value. Gas oil, heavy oils, tars and asphalt can be transformed by this direct process into motor fuels, and good results have been obtained experimentally with solid fuels of smaller calorific value like peat. The process depends upon the reaction of hydrogen under a pressure of 100 to 200 atmospheres, and at a temperature of 400 deg. Cent. The operation is continuous and the losses compared with those due to cracking are small, while it appears to be applicable to almost every kind of hydrocarbon product. In Belgium the treatment of bituminous schists by hydrogenation has given excellent results. A considerable amount of experimental work is being carried out with the hydrogenation system, which seems likely to permit of the utilisation of vast quantities of products that are at present regarded as of little value, and will consequently add appreciably to the supplies of light oils. Hydrogenation appears to follow the line of development opened up by the discovery of the catalytic process, which itself offers considerable promise in the economical treatment of petroleum, since the molecules are dissociated at atmospheric pressure, so that a much simpler installation than is required by cracking at high pressures can be employed. So far, experiments with catalysers have been restricted to vegetable oils, but there are obviously great possibilities in the future in the way of obtaining a higher proportion of spirit from the distillation of petroleum oils.

The interest of the Congress, however, was centred not so much in improved methods of distilling light oils from petroleum—which can only palliate the difficulty of diminishing supplies without remedying it—as in providing new sources of liquid fuel. The production of benzol, the hydrogenation of tars and the distillation of lignites and peat are making a notable contribution to the supplies. It was hoped that the enormous reserves of peat would have helped to provide some solution of the fuel problem, but while certain claims are being made in favour of peat, it does not appear as if much is likely to be done, except, perhaps, by its utilisation as a fuel for electrical generating plants in the centres of peat production. One such plant is giving satisfactory results in Belgium, and a company in France undertakes to lay down plants for the supply of electrical energy to towns and villages near peat deposits, it being claimed that the cost can be covered by the sale of by-products. It must, nevertheless, be recognised that the exploitation of peat has generally given poor results, on account mainly of the difficulty of drying it. The best method at present discovered is to stack it on shelves with a circulation of air, but as the rapidity of drying depends upon the atmosphere, and considerable areas have to be devoted to the stacking, the economy of the operation is an essentially variable factor. It is argued also that peat should be washed to free it from sand, which only complicates the problem. On account of its low calorific value, it does not pay to carry peat over long distances, and, for the moment, it does not appear as if much can be done except by the employment of the fuel on the spot for electrical generating plants. Nevertheless, trials carried out at Arras with a Crossley suction gas plant specially adapted for the burning of peat have emphasised the fact that there are great possibilities in the way of economical running on this fuel.

As the object at the moment is to reduce the petrol consumption in motor cars and for other purposes, so as not to encroach upon the supplies of petroleum and spirit for marine engines and aeroplanes, there are suggestions for making a freer use of suction gas and natural gas, the discoveries of exceptionally rich marsh gas at Vaux, in the Ain, and near Arcachon having raised the question whether the gas cannot be compressed in cylinders and distributed all over the country. Apart from the cost of distribution, which must be heavy, the experience of motor car users with gas under pressure does not encourage the belief that compressed gas will be largely employed for motor vehicles so long as liquid fuels are obtainable. Suction gas is the only practical solution at the moment. The liquefaction of coal gas under a pressure of 300 atmospheres may produce considerable quantities of motor spirit, if it be found commercially advantageous; but this is still in an experimental stage, although there appears to be no doubt that a high-grade motor fuel can be obtained. The commercial success of any process of liquefying coal gas can only be investigated in relation to the interests of other industries associated with coal by-products. Still, the method opens up a new line of research which may eventually result in the complete dissociation of the constituents of coal into various liquid and gaseous fuels at the collieries.

Benzol is at present the only by-product of coal that is capable of being used as a motor fuel, and the quantities available being relatively small, it is clear that if new sources of supply are to be opened up they can only be found in alcohol and vegetable oils. The production of industrial alcohol in France is just one-tenth of the total consumption of petrol. Therefore, the aim of the Comité Scientifique du Carburant National is to encourage the use of a fuel in which there is at least 10 per cent. of alcohol, preferably with the addition of other home products, such as benzol, until such time as the production of industrial alcohol shall have been so far increased that it will be possible to employ the spirit in engines specially designed to run on alcohol. Legislation in France has limited the human consumption of alcohol to that distilled from grapes and other fruits, the alcohol from beet and similar produce being reserved exclusively for industrial purposes. The object now is to cheapen industrial alcohol as much as possible, as any composite fuel must necessarily be sold at a lower price than petrol. While alcohol mixes perfectly with benzol and provides a fuel in every way as satisfactory as petrol, it does not mix with petrol unless previously dehydrated or by the addition of a dissolvent. Professor Daniel Berthelot stated that the Service of Explosives had discovered a very simple process of dehydration that raised the alcohol to 99.6 deg. and 99.7 deg. Apparently, this is done by passing alcohol vapour through a column of lime. The method is now being employed commercially, and there is no reason why pure alcohol should not be produced in considerable quantities. Various methods are employed for mixing alcohol at 95 deg. and 96 deg. with petrol, and for the time being this mixture is being used fairly extensively; but the presence of water is objectionable, and alcohol will only become entirely satisfactory as a constituent in composite fuels when the process of almost complete dehydration has been developed sufficiently to allow of its cost being reduced. In any case, it does not appear as if even an agricultural country like France will be able to produce enough alcohol to replace rectified petroleum, and Sir Frederick Nathan, in an interesting communication on the world's resources in fuels, pointed out that in the colonies the scarcity of labour and the cost of transport may stand in the way of cheap supplies to consuming countries. Therefore, we are far from reaching a period when the purely alcohol engine will be necessary, except in centres of production, like the colonies, where alcohol should be obtained at low cost. Meanwhile, the composite fuels can be used in existing engines, and the tests and experiments being carried out aim at determining the most suitable and cheapest mixtures, in which purely national products will enter the most largely. Sir Frederick Nathan mentioned calcium carbide as a source of alcohol on condition of sufficiently cheap motive power to produce it being available. In view of the vast hydraulic installations being carried out, this phase of the question may have some importance in the future.

Now that the difficulties in the way of dehydrating alcohol are being overcome, the problem of utilising this fuel in motors is practically solved, and its future depends upon legislative measures, and upon an organisation which will bring down the cost to the consumer. Nevertheless, the home production can never be sufficient to replace entirely imported mineral oils, even when alcohol is associated with all the other home products that may be available for the making of composite fuels. Therefore, the question arises whether imported oils cannot be replaced by synthetic petrol, and the most interesting feature of the Congress was the proof offered that this is well within the domain of probabilities. Vegetable oils are possible substitutes for all mineral oil fuels. They have the advantage of being entirely combustible, but, on the other hand, the temperature in the cylinders must be very high completely to burn the acids which would otherwise decompose the lubricating oils. The mere possibility of the acids not being completely neutralised, creates a certain reluctance to employ vegetable oils. Nevertheless, in the colonies these oils would offer an immediate solution of the problem of motor traction, to which Belgian engineers especially have been giving a great deal of attention, and M. R. E. Mathot dealt fully with the progress that has been made with colonial types of engines capable of running on locally produced fuels. The calorific value of vegetable oils is more than half as much again as that of alcohol, but, according to M. Charles, it must be burned at a temperature of 200 deg. to 250 deg. Cent., with a compression of 32 kilos. per square centimetre—say, 455 lb. per square inch—for palm oil and the oil of ground nuts. Some of the Belgian engine builders, however, argue that such a high compression is not at all necessary. The inflammation temperature is from 300 deg. to 350 deg. Cent. The oils are suitable for Diesel and hot-bulb engines, but these do not satisfy the requirements of colonial motor traction, which will probably be entirely met by high-speed engines of the Peugeot heavy oil type that has been running on touring cars with extraordinary results from the point of view of efficiency and economy. There was a good deal of discussion on the comparative merits of compressed air and mechanical oil injection, M. Mathot being a partisan of the mechanical system on account of the power absorbed by the air compressor and of the latter being an alleged source of trouble; but the final decision was that mechanical injectors did not give such smooth running in the engine, although they are preferable for moderate powers, especially for colonial engines. Another system of injection proposed consists in a preparatory pulverising of the oil in the volume of air which enters the cylinder in the form of gas. This is said to permit of the engines running at higher speeds.

The use of vegetable oils as fuel is limited by the cost, which is bound to be fairly high so long as the greater part of the production is absorbed for industrial and commercial purposes. There can only be an extensive use of vegetable oils as engine fuels when the African Colonies undergo a systematic development and improved methods of cultivation ensure a much greater yield of ground nuts, for example, per acre, whereby the cost will be reduced to something like the pre-war figure. The price at which vegetable oils are sold in the consuming countries is out of all proportion to the cost of production, which is something like 15 centimes per litre. A heavy surplus yield would inevitably bring down the selling price to a level that would permit of its being employed as a fuel. Even under present conditions, it appears possible commercially to transform vegetable oils into light oils having the same constituents as petrol. Professor Mailhe, who has been carrying out exhaustive experiments with the catalytic process of Professor Sabatier, showed a number of samples of oil that he had prepared from various vegetable oils.

The process consists in the dissociation of the molecules by means of two catalysers, one dehydrating and the other dehydrogenating, the nature of the catalysers varying with the character of the oils. Electrolytic copper is usually a good agent. The reaction is effected under temperatures of 550 deg. to 600 deg. Cent. On passing the catalysers, the oxygen is separated in the form of water, and a dissociation of molecules leaves the resultant liquid with all the constituents of petroleum. It is then passed over nickel at a temperature of 180 deg. Cent., when there is a dissociation of hydrogen, producing a good quality of petrol. The petroleum constituents are obtained by a separation of the acid fats which contain everything necessary for the synthetic combination of oils, identical with all kinds of mineral oils and petrol. The glycerine is removed and sold as a by-product. By the use of suitable catalysers, benzol, toluene and other products are obtainable, as well as gases which can be added to increase

the richness of poor illuminants like water gas.

The extraordinary adaptability of the catalytic process, and the facility with which the molecules of any oils can be dissociated and re-combined to form new products, appear to open up inexhaustible supplies of petrol and other liquid fuels. The only question is whether the process can become commercially successful. Professor Mailhe gave figures based upon estimations showing that there could be no doubt as to the commercial success of the catalytic method. The future, however, depends upon the supplies and cost of vegetable oils, and when the programme of colonial development has been carried out sufficiently to ensure adequate quantities of cheap vegetable oils, it will be possible for companies to produce synthetic oils of exactly the same nature as oils from all parts of the world at lower prices than the natural mineral oils. His synthetic experiments led Professor Mailhe to the conclusion that the origin of petroleum oils is due to the building up process of molecules, both animal and vegetable, under exactly the same conditions of chemical reaction and temperature, and the varied nature of the oils is explained by the differences in the chemical reactions to which they are subjected.

The Care and Maintenance of Diesel Engines.*

By GEORGE E. WINDELER, M.I. Mech. E.

We have previously referred to the very practical character of the papers which are read before the Diesel Engine Users' Association, and to the spirit of co-operation existing between the manufacturer and the user, which has resulted in increased efficiency and better running in stations and factories where Diesel engines have been installed. The paper read by Mr. George E. Windeler, the chief engineer of the well-known firm of Diesel engine

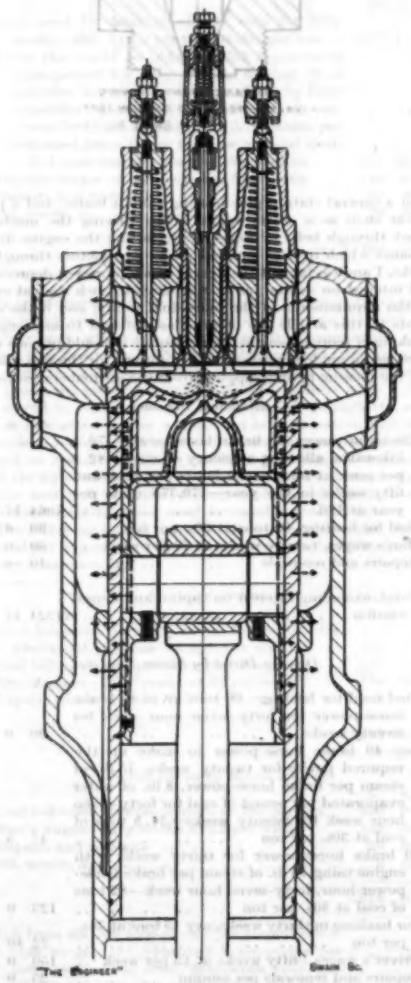


FIG. 1—SECTION THROUGH DIESEL ENGINE CYLINDER

builders, Mirrlees, Bickerton and Day, Limited, deals with important points in the running of engines, and we are indebted to Mr. Percy Still, the secretary of the Association, for permission to deal with it at some length, and also to reproduce certain illustrations.

Mr. Windeler prefaces his remarks with an appeal for careful observation and for frank and sympathetic co-operation between the supervising and the running staff, with a view to investigating troubles and defects and collecting data regarding them. The author states that he regards it necessary to adopt a simple routine to ensure that all parts requiring inspection, changing or overhaul are dealt with in correct sequence. A blackboard placed on the wall of the engine-room will be found very useful for the purpose of writing down any instructions from the supervisory to the running staff, and for recording information as to work done, which later may be tabulated for future reference. The main sections of the paper are dealt with in the following paragraphs.

* Abstract of a paper read before the Diesel Engine Users' Association, October 27th, 1922.

What is the Life of a Diesel Engine?

The answer is that there is no limit to its life providing it receives reasonable care and attention. Usually, the engine is carefully designed so that it is possible from time to time to fit new parts as and when required. Generally speaking, the parts which may require renewal are:—(1) Valves, seats and springs of main engine and of compressor and fuel pumps; (2) liners of main engine and compressor; (3) pistons and rings of main engine and compressor; (4) bearings; (5) cylinder covers; (6) cams and valve gear. In practice it is found that exhaust valves and seats require more frequent renewal than any other parts. Next in order come liners, pistons, rings, springs, bearings, cylinder covers, and at longer intervals, cams and valve gear. As worn parts can be replaced time after time, the efficiency of the engine can be maintained indefinitely. Engines which have been working for over twenty-one years are still running well, maintaining their high standard of economy and giving every satisfaction. The drawing reproduced in Fig. 1 shows in cross section the cylinder cover, valves, cylinder liner, piston and water jackets of a Diesel engine. On this section are shown lines indicating the path of heat units passing away to the water spaces. Approximately, a Diesel engine in good running order utilises in useful work or brake horse-power 34 per cent. of the heat units of the fuel oil delivered to the combustion chamber; 30 per cent. of the heat units pass away with the exhaust gases; and 25 per cent. pass away through the water jackets. The importance of keeping the surfaces to be cooled free from deposits such as carbonate of lime, sludge, vegetable matter, and other refuse will be readily appreciated; otherwise an uninterrupted flow of heat to the water jackets will not be maintained. Neglect of this important point produces serious overheating and causes:—(*a*) Loss of power through distorted valves and seats; (*b*) seized pistons through destruction of the oil film between liner and piston; (*c*) cracked cylinder covers and pistons. A long series of investigations has indicated that deposits are not necessarily formed on the surfaces while the engine is running, but more generally after the engine has been shut down, the reason being that the heat units stored in the valves, cover, piston and liner are sufficient to raise the temperature of the water lying in the jackets and to cause precipitation of the lime salts. Recommendations and arrangements have been made to allow water to flow through the engine for fifteen to twenty minutes after stopping, this being usually effected by means of an auxiliary overhead tank. By this means the water jacket temperatures are kept sufficiently low to prevent precipitation, and the engine parts are allowed to cool down gradually. It is important that the water-cooled surfaces should be examined periodically, and for this purpose suitable openings are now generally provided in all water-jacketed details. If the examination indicates the necessity for cleaning but shows that mud, sludge, or soft matter only has to be dealt with, then a thorough washing out of the jacket spaces will be sufficient. On the other hand, if the deposit is found to be hard, then the main liners and air compressor liners will have to be withdrawn and the internal surfaces scraped and cleaned.

In cases where exceptionally hard water is the only source of supply, it is desirable to install a small water-softening apparatus.

Where river or canal water is used, it has been found undesirable to draw the water direct from the river or canal, as, when the former is in spate or the latter is stirred up by shipping, a considerable portion of suspended matter is taken over and deposited in the jackets. In one instance which came under the author's notice where the water was drawn from a river, 4in. or 5in. of mud were invariably deposited in the cover water spaces in a week, when the river was in spate. The engineers materially reduced their trouble by building two settling chambers, one with a large mesh removable strainer to keep out heavy matter and the inlet to the second chamber arranged with two removable fine mesh strainers, set about 4in. apart, and between these were placed a large number of "loofahs." The loofahs are removed at periods when the river is normal, washed and used again. Mr. E. W. Johnston, of King's College Hospital, has forwarded me a very interesting communication. He stated that he had found that some liners showed signs of collapsing internally, whilst others did not, and that he had formed the opinion that the distortion was due to the liner being prevented from expanding longitudinally as is intended.

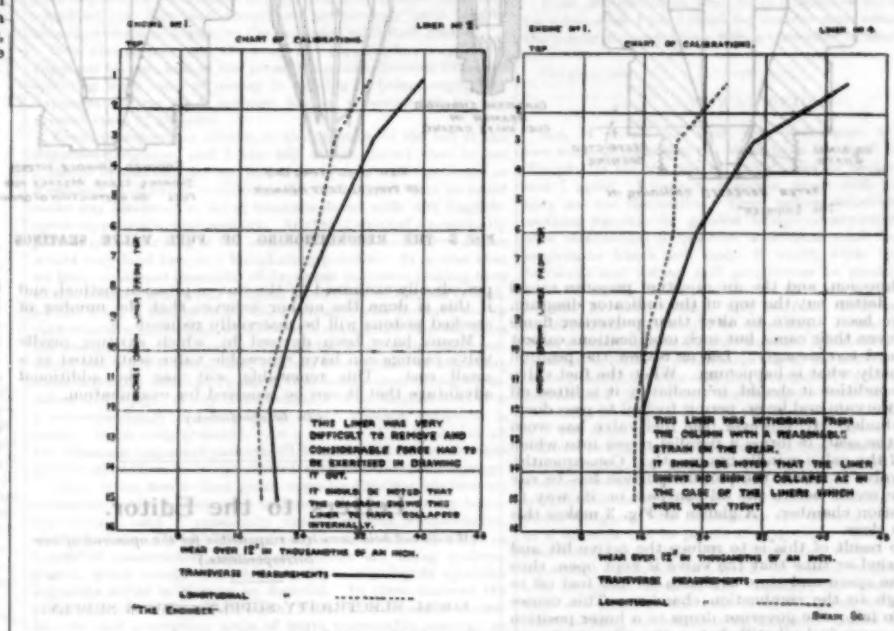


CHART OF CALIBRATIONS.
THIS LINER WAS VERY DIFFICULT TO REMOVE AND CONSIDERABLE FORCE HAD TO BE EXERCISED IN DRAWING IT OUT.
THIS LINER WAS WITHDRAWN FROM THE CYLINDER WITH A REASONABLE STRAIN ON THE GEAR.
WEAR OVER 12" IN THOUSANDTHS OF AN INCH.
TRANSVERSE MEASUREMENTS
LONGITUDINAL "

FIG. 2—DIAGRAM SHOWING LINER DIMENSIONS AND PORES

It was thought that this was owing to the liner being held rigidly at the bottom belt by accumulations of rust and scale. He therefore arranged to examine and calibrate the bores of the liners of the Diesel engines installed at King's College Hospital. He tabulated in "graph" form the results of his measurements, after which he had the liners withdrawn and noted carefully the difference in effort required to remove each liner respectively. Reference to two of the graphs shown in Fig. 2 shows clearly that Mr. Johnston's views are substantiated, as it was proved that the liner which indicated internal collapsing was very difficult to move. This would appear to be an important discovery and may account for some at least of the mysterious piston seizures which have taken place on different types and sizes of internal combustion engines.

Crank Shaft.

This important detail used to be considered a source of anxiety, but within recent years more careful supervision in manufacture has reduced troubles to a very low percentage. In The Engineer of April 1st, 1921, in an article on crank shaft alignment, we illustrated a simple, self-registering instrument which is available for this purpose, and which can be used also for obtaining accurately the amount of wear in the bore of cylinder liners. The author recommends that readings be taken between the crank webs at least four times a year, and that the crank shaft bearings be removed and examined at least once a year.

If for any reason a new crank shaft has to be re-fitted or a new bearing or bearings fitted to an existing shaft, care should be taken that sufficient clearance is allowed at each line of cylinders on the crank web nearest the fly-wheel. The necessity for this will be seen when it is remembered that the skew gear wheel is generally fitted between two bearings, so as to prevent the longitudinal movement of the shaft which is produced by the angular thrust of the skew gear wheel. By reason of this arrangement, the shaft is prevented from expanding at that end. Therefore, due allowance must be made for the shaft expanding wholly towards the other end. Serious damage has been done and shafts have even been bent owing to this important point not having received attention.

Fuel or Needle Valve.

This simple and yet important valve and its accessories require care and attention. The gland packed type of fuel valve is now almost universally adopted, and if it is properly manufactured gives very little trouble indeed. This valve generally takes the form of a long and somewhat slender spindle, with a guide portion at one end and the valve seat at the other end. Care must be taken in handling this valve. It should not be laid about on the work bench when removed from its position on the engine, as it can easily be damaged by articles being laid upon it. The author recommends that a wooden rack, pierced with holes, be fitted up in the engine-room and arranged in such a manner that the fuel valves can be stowed away vertically on it. Spare fuel valves should also be stowed away in this manner to prevent their becoming bent or otherwise damaged. Perhaps the most important point in connection with this part is the keeping of the valve seat in condition. It is important to observe that this valve should not be ground on to its seat with hard abrasives such as carborundum or flour of emery. These abrasives are difficult to remove from the seat and wear away the seating at a very rapid rate. It is recommended in the first place that the valve be rubbed on to its seating quite dry, and any hard portions removed with a small, smooth file; continue to rub metal to metal and touch up the faces with the file until an even bearing surface is obtained; then finish off with liquid metal polish and a little oil, gradually removing the oil and abrasive until a metal-to-metal condition is obtained again. This process is somewhat slow, but a fuel valve once conditioned in

this manner will continue to remain so for long periods, and should only require rubbing on its seat occasionally with a little lubricating oil.

Many troubles on the Diesel engine have been traced to the unsatisfactory condition of the fuel valve seat, not because of lack of attention to it, but because it has received the wrong kind of attention. Continually grinding in of a fuel valve with hard abrasives produces a serious wearing down into the valve seat and the valve becomes buried in the manner shown on Fig. 3. Such a condition brings a number of troubles in its train, as for instance:—(*a*) Loss of power and speed; (*b*) overheating and cracking of the parts exposed to the products of combustion, *e.g.*, pistons, cylinder covers; (*c*) distortion of the valves and their seatings in consequence of this overheating; (*d*) difficulty in starting. Unfortunately, this difficulty has not in the past been readily recognised. The first sign of it is late fuel admission accompanied by an attenuated combustion line, as shown by the indicator diagram. Instead of investigating the cause of the trouble the fuel setting is usually advanced to overcome the late admission, and the air injection pressure raised to try and flatten out the top of the indicator diagram. People have been known to alter their pulveriser flame plates and even their cams, but such modifications cannot be condemned too strongly. Let us review the position and see exactly what is happening. When the fuel valve is in good condition it should, immediately it is lifted off its seat by the cam and lever, permit fuel oil to pass down into the cylinder. If, however, the fuel valve has worn down into the seat, it forms a parallel recess into which the body of the valve spindle fits exactly. Consequently, when the valve is lifted, the parallel portion has to rise clear of the recess before the oil can pass on its way to the combustion chamber. A glance at Fig. 3 makes this point quite clear.

Now, the result of this is to reduce the active lift and also the period or time that the valve is kept open, thus reducing the space and time available for the fuel oil to pass through to the combustion chamber. This causes the speed to fall; the governor drops to a lower position and admits more fuel oil still, but as the oil cannot pass into the combustion chamber at the correct time, after-burning takes place, with its attendant trouble of over-heating. The trouble is accentuated by the dilution and overheating of the incoming air with inert gases which reduce its ability to sustain combustion of the fuel oil blown into it. Loss of power and speed, accompanied by knocking, overheating and the emission of heavy black smoke at the exhaust ensues if the engine is kept running under these conditions. Further, the valves and their seatings become distorted and burnt, and there is a danger of the piston seizing and of cracking of the parts exposed to the combustion space.

It can be readily appreciated how difficult it is in the ordinary way to analyse this trouble and discover the extent of the wearing in of the valve seat. The position of the seat in a remote place at the lower end of a long casing makes access difficult and accurate examination impossible. Generally, a small mirror is used for examination purposes, but the extent of the fault cannot be measured by that means. The author was faced with this problem, and decided to try another method, which has proved most effective. Proceed as follows:—

Carefully clean out the fuel casing; take a stout wax candle and warm the pointed end until it reaches a plastic condition for about 1in. up of its length. Next pass the wax candle down into the fuel casing and press it firmly on the seating at the lower end; hold there until the wax has set firmly, turn the casing upside down and knock out the wax impression. If it has been treated in a proper manner, a perfect model of the worn seating will have been obtained. From this the exact extent of the wearing in can be measured and the necessary steps taken to remove the trouble.

It is usual when the seats have been found to be worn in to reamer out the seating as shown in Fig. 3, but this is not always possible, and the following method will be found to be equally effective.

From the wax impression, measure the exact amount of the recess which has been worn into the seating. Take the needle valve and mark off from the top edge of valve face this amount, plus, say $^{3}/_{16}$in. Then take a $^{3}/_{16}$in. rat-tail file and file a semi-circular groove about $^{1}/_{16}$in. deep round the valve spindle, letting the edge of the groove coincide with the top edge of the valve face. Then file a chamfer from the groove to the point marked higher up on the spindle; let the chamfer at the lower end be filed until it coincides with the bottom of the groove—see Fig. 3. This should produce an elongated tapered recess immediately above the valve face, which will form a passage or port behind the parallel recess in the valve seat and permit the fuel oil to pass freely directly the valve is lifted from its seat. No other alteration should be necessary.

The author has known an engine, which normally was capable of easily developing 150 brake horse-power, prove unable to develop 20 brake horse-power without falling in speed, and beyond this load, accompanied by heavy knocking, it showed a smoky exhaust and general signs of distress. The fuel valves and their casings were examined and treated in the manner described. The other valves were cleaned and readjusted, after which the engine was easily able to maintain its normal full output.

The wax impressions taken from the fuel casings indicated that the valves had worn down into the seatings about $^{3}/_{32}$in.—almost the total amount of the fuel valve lift.

It is recommended that all fuel casings should be periodically examined by the wax impression method, and if this is done the author believes that the number of cracked pistons will be materially reduced.

Means have been devised by which existing needle valve casings can have renewable valve seats fitted at a small cost. This renewable seat has the additional advantage that it can be removed for examination.

(*To be concluded.*)

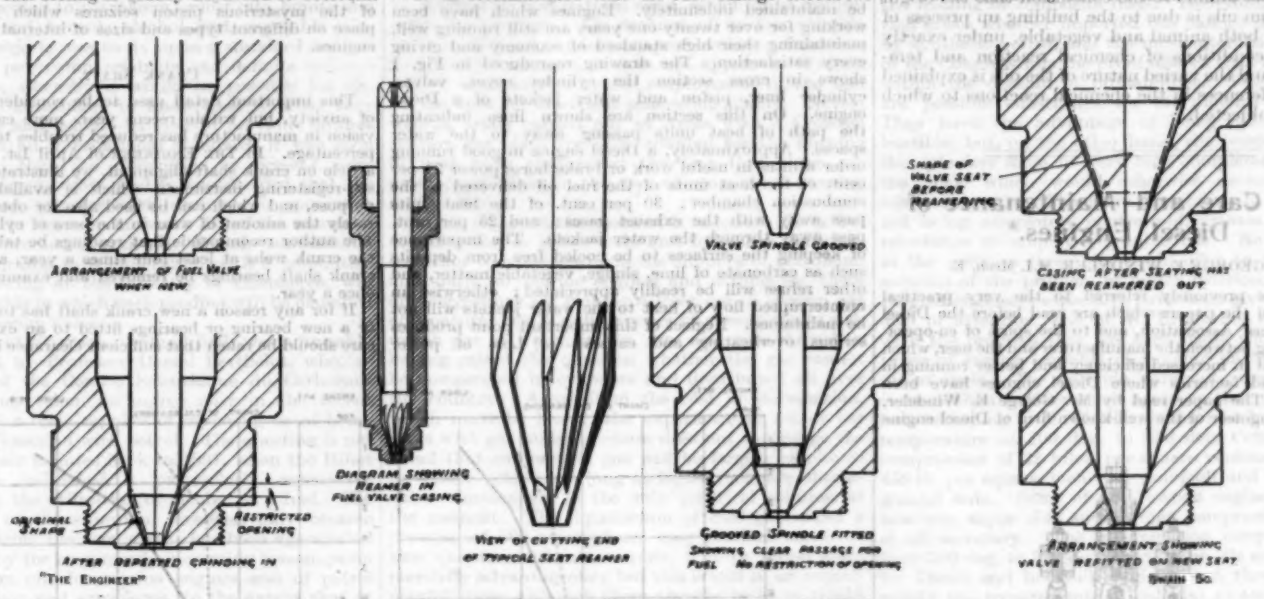

ARRANGEMENT OF FUEL VALVE WHEN NEW
ORIGINAL SHAPE
RESTRICTED OPENING
AFTER REPEATED GRINDING IN "THE ENGINEER"
DIAGRAM SHOWING REAMER IN FUEL VALVE CASING
VIEW OF CUTTING END OF TYPICAL SEAT REAMER
VALVE SPINDLE GROOVED
GROOVED SPINDLE FITTED SHOWING CLEAR PASSAGE FOR FUEL NO RESTRICTION OF OPENING
SHAPE OF VALVE SEAT BEFORE REAMERING
CASING AFTER SEATING HAS BEEN REAMERED OUT
ARRANGEMENT SHOWING VALVE REFITTED ON NEW SEAT
SWAIN &Co.

FIG. 3 THE RECONDITIONING OF FUEL VALVE SEATINGS

Letters to the Editor.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

LOCAL ELECTRICITY SUPPLY *v.* BULK SUPPLY.

SIR,—At the end of the war the manufacturing community of Great Britain was pledged somewhat hurriedly to a policy of extending existing power stations and building new ones. To a certain extent this policy was a wise one on the ground that electricity can be manufactured in bulk, like many other commodities, at a cheaper rate than it can be produced in small quantities. Further, that it is possible to put down plant to recover by-products when the most recent advances in central station engineering have materialised, thus effecting a saving in the possible selling price of electricity. Further cheapening of electrical power may be found practical in the near future where power stations are situated in urban districts by selling as a by-product the waste heat obtained from the cooling water, working with a lower vacuum and consequent higher terminal temperature and selling the hot water so obtained for industrial purposes, such as heating factories, and even for domestic purposes for heating houses and providing hot water for the inhabitants. This would depend on the invention of a suitable pipe with some system of non-conducting covering produced at a commercial figure.

With all these advantages before us it is a fact which recently has been apt to be overlooked that it is not always a paying proposition to install electricity obtained from a central station. Power obtained from small electrical units generated on the spot or from a direct drive from a prime mover can often show a very considerable saving. To illustrate this we may take the following examples.

Let us consider the most general case of a factory which requires heating during the winter months.

It is a common and economic system to heat the factory by steam, either by having steam pipes arranged round the various departments, or by the more recent practice of having a battery of tubes heated by steam over which is driven cool air which takes up heat from the surface of the tubes.

In this case a boiler and the necessary boiler fittings are already installed; an attendant is there, at all events during the winter months. It would be practically as economical to produce the steam at, say, 180 lb. per square inch as at 40 lb. or 20 lb. per square inch, and by having a steam engine using the steam at an initial pressure of 180 lb. per square inch and exhausting it into the heating system at 20 lb. per square inch, power could be obtained at the rate of 1 brake horse-power for every 20 lb. to 25 lb. of steam per hour used for heating.

It may be of interest to take a concrete example of a factory that the writer has in mind—an engineering establishment employing 150 hands. The coal used per year was 60 tons, and the heating was supplied to the shops during twenty weeks in the year. Assuming 10 tons of coal were used for banking the fires at night and week-ends, this would leave 50 tons for heating the works. From this we gather the coal used for heating the factory equals 2½ tons of coal per week.

The factory worked forty-seven hours per week, so that the amount of coal per hour would be 119 lb. Each 1 lb. of coal would produce, as a conservative estimate, 8 lb. of steam. Steam produced per hour would be 952 lb. This would give 952/20—47.6 brake horse-power, say 40 brake horse-power, allowing 7.6 brake horse-power for contingencies.

The factory alluded to above requires an average of 80 brake horse-power. It may be of interest to compare the power costs of two schemes, the first one driving the factory by electric power supplied from an outside source, the second driving the factory by a compound steam engine taking the steam for heating purposes from the receiver between the high-pressure and low-pressure cylinder during the winter months and running the engine fully compound during the months that no heating is required in the works.

Now, in considering these two cases, *i.e.*, electricity supplied from a central station plus heating from a boiler, and a prime mover such as a steam engine either driving the machinery direct through belts or ropes, or by letting the engine drive a dynamo which in turn supplies current to motors through the works, I am leaving out the figures which represent depreciation and interest on capital, as this depends to such a great extent on the requirements of the individual works, and if the statements in this article are of practical interest to any engineer thinking of reorganising his power supply it would prove a much more useful guide if estimates were got out for the two schemes and the missing figures supplied from the estimates received.

Electrical Scheme.

	£	s.	d.
Electrical power, 80 brake horse-power—72.5 kilowatts, allowing efficiency of motor 82.5 per cent. at forty-seven hours per week and fifty weeks in the year—170,375 units per year at 1½d.	1064	17	0
Coal for heating, 60 tons at 30s. per ton	90	0	0
Man's wages, twenty weeks at £3 per week	60	0	0
Repairs and renewals	10	0	0
Total, excluding interest on capital and depreciation	£1224	17	0

Driving Direct by Steam Engine.

	£	s.	d.
Coal used for heating—60 tons gives 40 brake horse-power for forty-seven hour week for twenty weeks	90	0	0
Say 40 brake horse-power to make up the required power for twenty weeks, 15 lb. of steam per brake horse-power, 8 lb. of water evaporated per pound of coal for forty-seven hour week for twenty weeks—31.5 tons of coal at 30s. per ton	47	5	0
80 brake horse-power for thirty weeks with engine using 13 lb. of steam per brake horse-power-hour, forty-seven hour week—82 tons of coal at 30s. per ton	123	0	0
For banking in thirty weeks, say 15 tons at 30s. per ton	22	10	0
Driver's wages—fifty weeks at £3 per week	150	0	0
Repairs and renewals per annum	25	0	0
Oil, waste, &c.	10	0	0
Total, excluding interest on capital and depreciation	£467	15	0

From these figures it appears that the prime mover effects a very considerable saving (assuming that electricity cannot be obtained at a cheaper rate), and that there is a good margin available for extra depreciation and interest on extra capital to be absorbed before the electrical scheme competes with the steam engine.

It may be further worth while to consider some examples of industries which require, besides power, heat for various processes in the works, and I shall give two examples, the first a woollen mill which requires a considerable quantity of heat and moderate amount of power, and as the extreme case a dye works, which requires a great quantity of heat and very little power. In the first of these examples one is able to extract a big proportion of the power from the heating steam before it goes to the works, making up the comparatively small remaining proportion

of power by means of the engine using the remaining steam fully expanded. The second example of a dye works, where a great quantity of steam is used for the various processes and comparatively small quantity of power is required. In this instance, if all the power were extracted from the steam by means of a steam turbine or engine (which would not emit oil through the exhaust) it would be possible not only to supply the whole dye works with power extracted from the steam used for their processes, but as it is possible to obtain more power from the process steam than is wanted in the works, cheap power could be sold to neighbouring industries at a very low rate.

These two examples must be taken as typical ones, the figures of the woollen mill being drawn from an actual case where spinning and weaving and finishing go on under the same roof.

It would be interesting to compile figures for the various industries that require heat and power at the same time, such as cotton, papermaking, &c., but it would make this letter too long, and when all the figures were set out they could only be taken as an approximate guide, as local conditions enter into the final figures to such a large extent.

The mill in question takes 300 indicated horse-power from a steam engine. The total coal consumption was 28 tons per week, and of this, from as reliable tests as could be made, the steam consumption of the engine was 16 lb. per indicated horse-power per hour. Assuming a boiler evaporation of 7 lb. of steam for 1 lb. of coal, we get weight of feed water to the engine per week—$300 \times 47 \times 16 = 225{,}600$ lb. Coal for power per week, 32,229 lb. = 14.35 tons per week, leaving 13.65 tons per week for process and banking. The following figures were submitted to the management who were considering bringing their power plant up to date. The steam engine being the same type as in the previous heating scheme.

Electrical Scheme.

	£	s.	d.
245 units for forty-seven hours for fifty weeks—575,750 units per year at 1¼d.	2998	13	11
Coal, 13.65 × 50 = 682.5 tons at 30s. per ton	1023	15	0
Boiler attendant's wages—fifty weeks at £3 per week	150	0	0
Repairs and renewals, oil, &c.	50	0	0
	£4222	8	11

Driving Direct by Steam Engine.

	£	s.	d.
Coal used for heating—13.65 tons for fifty weeks—682.5 tons per year at 30s. per ton ..	1023	15	0
From this could be obtained 229.5 indicated horse-power for fifty weeks, leaving 70.5 indicated horse-power to be made up by fully expanded steam. 70.5 indicated horse-power for fifty weeks using 12 lb. of steam per indicated horse-power forty-seven hour week—111 tons coal per year at 30s. per ton ..	166	10	0
Driver's wages—fifty weeks at £3 per week ..	150	0	0
Repairs and renewals	45	0	0
Oil, waste, &c.	20	0	0
	£1405	5	0

In considering the case of the dye works, there are complications which arise that do not come into the two previous cases. In this case, where the power is small in comparison to the steam that has to be used for process purposes, the steam used for these processes is generally intermittent. If it can be used for producing power before it is used for process work it has to be stored in reservoirs after it has passed through the engine till it is wanted in the works. As an alternative, the superabundant power could be stored in electric batteries and distributed as required. This may make the scheme impractical, and the figures in the last example are to be taken merely as a guide, and it is doubtful if they could be obtained in actual practice excepting under most favourable conditions.

The following figures are of a dye works which uses 500 tons of coal per annum, and the power taken is only 30 brake horse-power continuously.

Electrical Scheme.

	£	s.	d.
27.5 kilowatts for forty-seven hours for fifty weeks—64,625 units at 1¼d. per unit	403	18	0
Coal bill—500 tons per annum at 30s. per ton ..	750	0	0
Man's wages—fifty weeks at £3 per week ..	150	0	0
Repairs and renewals, &c.	8	0	0
	£1311	18	0

Driving Direct by Steam Engine.

	£	s.	d.
Coal bill—500 tons per annum at 30s. per ton ..	750	0	0
Man's wages—fifty weeks at £3 per week ..	150	0	0
Repairs and renewals	20	0	0
Oil, waste, &c.	8	0	0
	£928	0	0
But from the 500 tons of coal per annum one is able to get 197 indicated horse-power for forty-seven hour week, fifty-week year, say 37 indicated horse-power goes into the works, which leaves 160 indicated horse-power to be disposed of, say 90 kilowatts for forty-seven hour week, fifty-week year—211,500 units per year. If these could be disposed of at 1d. per unit a further saving would be effected of	881	0	0
Which would leave the power bill at per annum	47	0	0

In actual practice manufacturing concerns will be proportionately near one or other of the examples given. The writer does not pretend to say that in every case it is more efficient to produce power in the works themselves, as there are so many local factors to consider, but if power costs are to be brought down, it will pay to have the power and heating scheme laid out together with one or two alternative methods, especial facilities being given to the engineers who are quoting for the power plant to take into consideration the full utilisation of any steam used in the factory for purposes other than power production.

October 24th. W. S.

JAPANESE TRADE.

SIR,—A letter appearing in your issue of October 13th dealing with this subject contains much of interest, and as I have also just returned from a long trip in the Far East I should like to make some comments on the matter.

In the first place, "Outland Voyager" entirely ignores the British merchant resident in Japan, and seems to think that any representative of a responsible firm has only to go out armed with information and credentials to secure orders on the spot! This is practically an impossibility. Apart from his ignorance of the language he does not know to whom to turn, and although he will doubtless be received with perfect politeness, it is only in very exceptional cases that he will get any further.

It must be acknowledged that it is one thing to manufacture and quite another thing to distribute. This is an important point even in effecting sales in this country, and doubly so when dealing with clients in foreign lands, and it is essential from the manufacturer's point of view that he should get into touch with a really responsible British firm domiciled on the spot, and preferably one of sufficiently long standing and importance to maintain branch offices in various parts of the country. In a land like Japan, which stretches through latitudes comparable to a distance reaching from Edinburgh to Madrid, it is obvious that there are many important centres with dealers and users whose confidence and support can only be obtained by personal calls and fairly frequent interviews. It is only by organisations such as these that bad debts can be eliminated and interest be maintained, and it is perfectly obvious that the merchant who acts in this capacity more than fully earns the slender margin which he claims as his share of the deal. The vicissitudes of trade during the last ten or fifteen years have had a tendency to eliminate the smaller man and to leave in the running only those who are well rooted in the ground and whose interests demand that they should perfect their organisations and avoid that rashness which has been thundoing of so many.

Taking "Outland Voyager's" points in detail, I agree that America looms large at present in Japanese eyes. That is the inevitable result of the opportunity which America had in the early years of the war of dealing with matters with which from *force majeure* we were unable to cope. In consequence, American specifications, American terms and phraseology have largely become current in Japan, to the exclusion of British custom.

It is also correct that Germany is "sapping her way" into Japanese favour, and at the present moment German firms are spending large sums of money in sending technical experts to Japanese centres in a manner totally unwarranted by the present state of business.

Your correspondent alludes to the question of the use of the Japanese language, and I can say at the outset that unless a visitor to that country has had years of previous experience as a resident in Japan it is almost ludicrous to think that he could make any headway in doing business direct with non-English-speaking people in that country. Anything short of a practically perfect understanding of the language and the customs of Japan would only land him in a humiliating position. It is true that we have continual examples of Japanese engineers coming over to this country with a fair working knowledge of English (which, by the way, is taught in all their schools) who pretend not to understand what is said to them and apparently depend upon the services of an interpreter, who all the while understand perfectly well what is being said, and use this method of absorbing ideas in greater detail and gaining time before committing themselves to a reply. If any representative of an English firm is in a correspondingly happy position when visiting Japan he is greatly to be congratulated. As a matter of fact, almost all the Japanese engineers understand English and before the war almost all of them were conversant with the German language.

There is no doubt that great opportunities for engineering enterprise await anyone who will take the pains to dig below the surface, and I personally visited several hydro-electric stations, some of which were already completed and others in course of construction, and many others are being contemplated, which would have done credit to any highly qualified engineers either in Europe or America. In these stations the plant was of American, Swedish, Swiss and Japanese manufacture, and generating units of quite respectable size (up to 12,500 kVA turbo-alternators) were to be seen in Osaka and elsewhere.

As regards belting, the majority of this is made in Japan, but a certain amount is still imported, and your correspondent is right in insisting on the necessity for samples, &c., being freely supplied.

Where the British manufacturer at present falls down is that, although he prepares excellent catalogues with prices for the home market, these catalogues in the majority of cases absolutely fall short of requirements for exporters' use. Rarely can any shipping specifications be found, *i.e.*, weights, cubic measurements, number of packages and details of heavy lifts. This information has usually to be "dragged" out of the manufacturer even though all inquiries specify that such data must be given. Consequently, the man on the spot who is dependent upon the aid of British catalogues is generally unable to quote in competition against urgent inquiries, whereas these particulars are always to be found in the hands of German or American competitors, together with the fullest technical details of machines, accessories, and all possible extra parts. Promise of shipment is also another matter which the average British manufacturer seems to regard as unimportant when making his tender. Lack of the information given above, which is absolutely essential for prompt dealing with business, is at the root of half our troubles, and if the merchant in London finds difficulty in extracting information which appears to require fresh calculations and detailed study before a reply is received from the works, how is it to be expected that the unfortunate representative of the manufacturer or of the British commercial house, when operating 10,000 miles from his base, can deal adequately with the situation.

Concerning tin-plates, the British manufacturer led the world before the war, and at equal prices can still offer as good quality as his American competitor, but, curiously enough, the complaints made against the present manufactures of tin-plates, which are due principally to war conditions—and these, despite all assurances to the contrary, are still in evidence—differ in nature from those levied against the American article; that is, the American article appears to avoid the troubles experienced with the British, and *vice versa*, but in the question of packing the American system is undoubtedly better than the British.

Whoever goes out should, of course, be in a position to answer all technical questions concerning the goods he is pushing on all lines manufactured by his principals. The representative of a merchant house finds himself in a further difficulty due to the wide range of subjects with which he is supposed to be conversant, and frequently has to pose as a universal expert—an individual who has yet to be discovered!

It is, of course, essential that whosoever is sent on such a mission is a man of personality and polish, who will be able to meet and associate with all classes of Japanese officialdom.

October 19th, 1922. COLOMBUS.

THE STUDENT IN THE FACTORY.

SIR,—In your article on "The Student in the Factory," while giving some excellent advice to the average student, you omit the case of the ex-Service student who lost some years during the war and has now reached the age when he must earn enough to keep himself. Hundreds of such men left the colleges in July, and in many cases their parents will be unable to assist them during even a short apprenticeship.

Take my own case as a typical one. I think I may claim to be what you define as a born engineer, as I gave up a chance of taking over a prosperous business, in spite of family opposition, to enter an engineering college before the war.

I joined the Army at the outbreak of war and was demobilised in 1919, losing five years altogether, during which time the only useful things I learnt were the working man's point of view and how to use a pick and shovel.

I rejoined the college in 1919, and finished my course in July, 1922, when I obtained the London B.Sc. Since then I have been doing odd jobs on a farm to keep my small capital from total extinction.

I am twenty-seven years old now, and was married soon after the war, when the trade prospects seemed brighter, and I have now a small family to support.

If you or any of your readers can advise me how to obtain the necessary practical training and at the same time support myself and family I shall be very much obliged.

I think you are inclined to underestimate the value of the practical training given in the colleges at present. I spent rather more than 70 per cent. of my last year in practical work (shop, drawing-office, testing, &c.), and more than 50 per cent. of the time in the previous years, most of the theoretical work being done at home.

Even if some of us were fools enough to forsake munitions for a less skilled job I think we deserve more consideration than the young student whose parents are able to assist him.

A. F. T.

October 21st.

RAILWAY BRIDGES.

SIR,—I would like, with your permission, to make one or two remarks regarding the letter from Mr. F. B. Howard White. His plea is for the use of nickel steel in bridge construction, and I agree. I cannot, however, agree with his deductions; they are too theoretical. First, before nickel-steel plates and sections suitable for general bridge construction can be sold as a commercial proposition a demand must be created of a magnitude which will make it worth while for steel manufacturers and rolling mill proprietors to produce it at competitive rates. I am not aware that such steels are on the market in bulk to-day, and to fulfil your correspondent's requirements that would be necessary. It always pays to use what is easily and quickly obtainable, is constantly being manufactured in bulk, of which large stocks are held, from which good service can be guaranteed, and in regard to which replacements, urgent and unexpected requirements can be at once met. Secondly, in suggesting that the weight of a bridge built partly of 3 per cent. nickel steel, and partly of carbon steel, could be reduced to one-half that of an all-carbon steel one, I think your correspondent has forgotten one salient feature of structures; that anything from 10 per cent. to 20 per cent. of a bridge's weight consists of secondary and tertiary bracing which is never stress designed. Its dimensions are determined not according to a formula but to practical exigencies. Now, even if nickel steel were used, these dimensions, and so the weights of the structure, would not be halved. It would be almost impracticable to reduce them at all. Thirdly, the question of impact does not tend, in the case of nickel steel, to a reduction of effective area, but rather to an increase. Under the Izod impact tests nickel and nickel-chrome steels do not show such good results as the carbon so-called mild steels used ordinarily in sections and plates. As the percentage of nickel increases in steel so its capacity to resist shock decreases. Thus, if impact is still to be allowed for, a generous formula will be necessary in nickel steel structures. Fourthly, taking the cost of a structure, the ultimate cost is the rational one to consider, and hence the life of the bridge is important. Corrosion is here the determining factor. Using nickel steel and securing a reduction in cross-sectional areas and weights of members, we do not get a corresponding reduction in total areas. The rate of destruction by corrosion depends on the proportion of cross-sectional area to exposed area, as the latter is attacked by the corrosive elements. The overall dimensions of members in a nickel steel structure will not be greatly reduced because of moments of intertia, &c. So that we have members with the same exposed areas but greatly reduced weights, &c. Now, 3 per cent. nickel is not going to add much to the corrosion-resisting qualities of the steel, and pitting in a ¼in. nickel steel plate will be far more serious than the same pitting in a ¼in. carbon steel plate. For instance, a 10in. by 6in. joist has twice the cross section and weight of a 9in. by 4in., but the exposed areas per inch of length are 41 square inches and 31 square inches. Thus the verdict in a comparison between a 9in. by 4in. nickel steel joist and a 10in. by 6in. carbon steel one is against the nickel steel so far as corrosion is concerned. These four items demonstrate that in any examination of the merits or otherwise of nickel steel for bridge construction caution must be exercised and indicate that a certain time must yet elapse before the use of that material becomes general practice.

STUDENT, I.C.E.

October 23rd.

THE GEORGE RICHARDS' FUND.

SIR,—You were good enough to insert an appeal on behalf of Mr. G. Richards recently in your paper, and I shall feel obliged if you will insert a further note to the effect that the Machine Tool Trades Association has voted £100 towards the fund, and is sending out an appeal to its members to contribute in their individual capacity.

London, October 24th. L. N. BUBT.

Strengthening New Holland Railway Pier.

A CONTRACT has been let by the Great Central Railway Company for the strengthening of the pier on which its line is carried from New Holland Town to New Holland Pier Station. The section of railway, of which the pier forms part and which after construction was incorporated in the Manchester, Sheffield and Lincolnshire Railway, and subsequently in the Great Central system, dates from the year 1848. The pier is the Lincolnshire shore terminus of the ferry service between New Holland and Hull, and for many years past a considerable volume of traffic has been carried between Hull and the Grimsby area and destinations south thereof. The pier, which has a length of 1370ft., with a width of about 35ft., was constructed to carry two railway tracks, a footpath, and a carriage-way for road vehicles. It is a timber trestle structure, built in bays of about 50ft. span, carried on piles. The structure has not, during a period of seventy years, undergone any very extensive repairs, all that has been carried out being necessary renewals of the timber work. Some years ago—indeed, in the pre-war period—it was realised that the pier would have to be strengthened to meet modern traffic conditions, and as it was impossible to execute works of this character during the period of hostilities, recourse was had to the abolition of double-line working and the substitution of a single line in the centre of the pier, and restrictions on the weight of engines passing over it. It is felt, however, that the strengthening of the pier must now be carried out without further delay, and the assent of the Humber Conservancy Board and the Board of Trade having been given to the plans of Mr. Harry Blundell, chief engineer to the Great Central Railway, under whose superintendence the work will be carried out, the contract has been let to Messrs. Logan and Hemingway, of Doncaster.

The method which is to be adopted for strengthening this old timber structure is illustrated in the plans which we reproduce. It is proposed to strengthen twenty-one of the bays, starting from the shore end, by sinking between the present rows of piles a pair of cylinders under each bay. The cylinders, which will be sunk into the chalk at a depth of about 64ft. below high water, will, as regards the sunken portion, be probably of steel and of 7ft. 6in. diameter, but above ground the cylinders will be of cast iron of 6ft. diameter. The work of sinking forty-two such cylinders and filling with concrete will occupy a considerable time, as the traffic must be kept going during the whole period of operation, and this will call for special arrangements in connection with the openings which must be made in the superstructure of the present pier, to enable the cylinders to be placed in position. When they have been sunk to the required depth, each pair of cylinders will be connected together by steel bracing, and will then for a time form a support to the existing timber superstructure. The intention is that the cylinders should form part of an entirely new pier of modern design, to the completion of which consideration will be given later. This work will, it is understood, enable the restrictions on types of locomotives using the pier to be withdrawn.

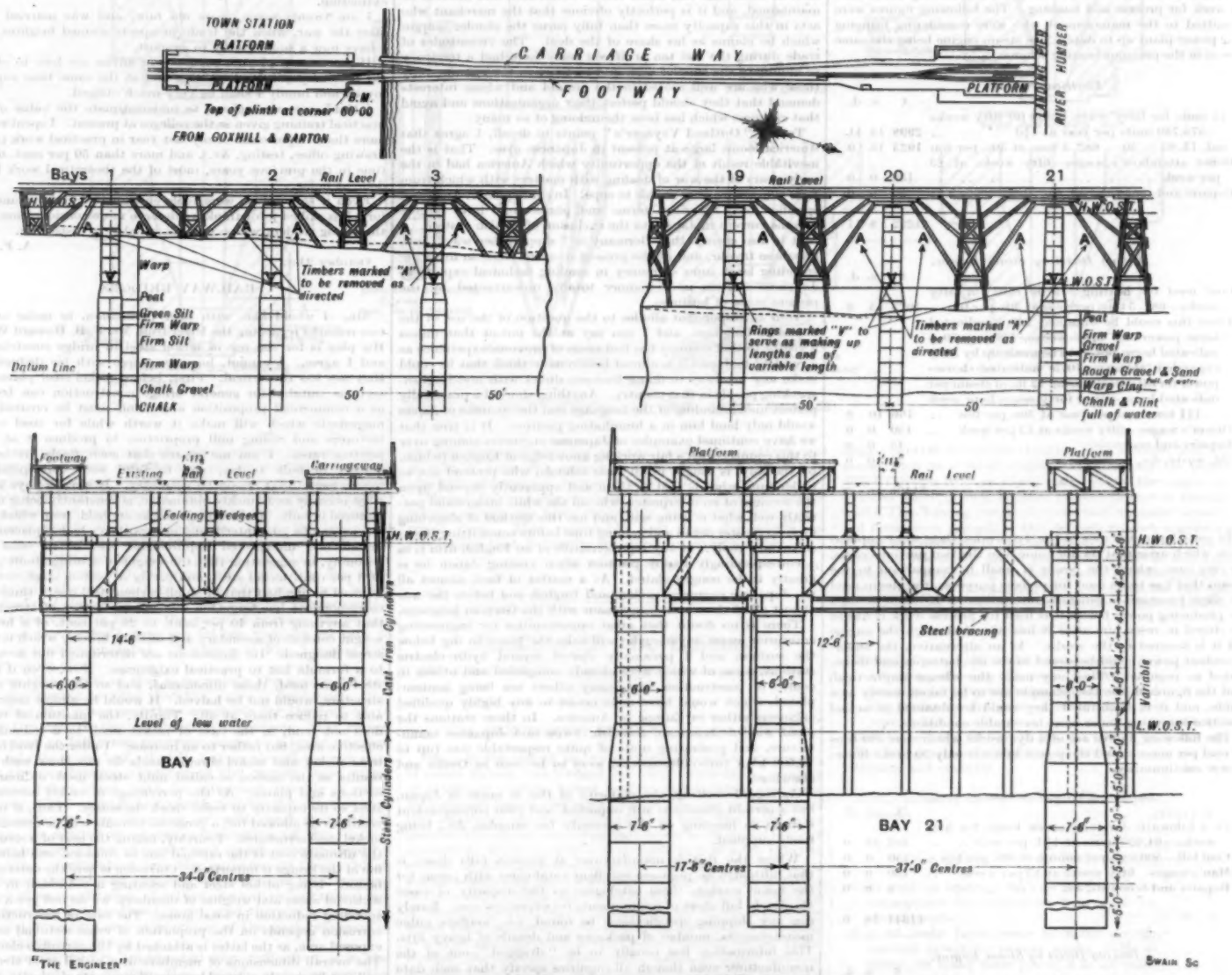
The Preservation of Iron and Steel.

In his presidential address to the Oil and Colour Chemists' Association on Thursday, October 12th, Dr. J. Newton Friend dealt mainly with experiments he has carried out in regard to the preservation of iron and steel from corrosion and rust. As illustrating the importance of the subject, he referred to the estimate made by Sir Robert Hadfield that 28 million tons of steel are lost annually by corrosion, and said that if we took an average of £20 per ton, the monetary loss amounted to nearly £600,000,000 per annum. Dr. Friend added that he knew a Midland firm which had calculated that the painting of their works worked out at £1 per ton of metal surface painted per year, and as there were 10,000 tons of metal, the annual cost of painting was £10,000. As the painting experiments were set out as impurities in the metal, variation in the weather, positions of the plates, application of the paint, extent of corrosion and method of weighing.

Discussing the functions of a perfect vehicle, Dr. Friend said it should protect the painted surface, bind the pigmentary particles, and expand and contract with the painted surface. As regards linseed oil as a vehicle, it rapidly absorbed oxygen, giving a clear substance known as linoxyn, the chemical composition of which was still a matter of discussion; but it was that fact which gave linseed oil its superiority over any other vehicle. If linseed oil were a perfect vehicle, it would not allow moisture to penetrate the linoxyn. It was a disadvantage that linseed oil should be slightly porous, and in order to see whether the porosity could be reduced, some experiments were carried out which led to the conclusion that if the oil were heat treated to get polymerisation, it was possible to reduce the porosity.

Passing on to the perfect pigment, Dr. Friend described the functions of it as follows:—Mechanical support to linoxyn, reduction of permeability, increase of viscosity, and reduction of the amount of expansion on setting. Experiments had been made upon the effect of colour of the pigment upon the durability of a paint. The experiments were with red, black and white pigments, and it had been found that in daylight the effect was different from that which was obtained in the dark. In the dark all three behaved similarly, but in the light oxidation was very much accelerated in the case of white. It was obvious from these experiments, that colour had a great deal to do with the disintegration of paint once it had been applied. The nearer we got to the red end of the spectrum or the black, the longer was the paint likely to last.

Another important point was the fineness of the pigment. The physical properties of a pigment were influenced by the state of subdivision, and the finer the pigment the more thoroughly would it become incorporated with the oil. The best paint could be expected when the pigment was finest, generally speaking, but there were other things to be considered. The pigment might lose body as it became exceedingly fine, and the cost of grinding might become disproportionately large after a certain diameter of particle had been reached. His experiments showed that after a pigment had been ground to a good commercial quality, say, 200 mesh, then it had reached a very efficient state of subdivision, and very much finer grinding would only affect the paint to a small extent. As to the effect of variation of pigment percentage, the best result appeared to be obtained with 60 per cent., which was about the percentage which practice had found to be the best, and it seemed that by accident rather than otherwise, painters had hit upon the best proportion for a mixture for painting steel.



ARRANGEMENTS FOR STRENGTHENING NEW HOLLAND RAILWAY PIER

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

The Trade Position.

Though no appreciable change has taken place in the position of the iron and steel industry in the Midlands during the past week, the evidence of the slight but steady improvement noted in recent weeks continues. The depression persists in the South Staffordshire area, where industrialists have not participated equally with some others in the improvement, and where the curtailment of output of basic pig signalises the partial failure of the courageous effort which was made to re-animate the steel manufactures. High railway rates have made this inland district more dependent on the home trade than formerly, and it is in the home trade that the depression is most pronounced. Heavy foundries in some parts of the country are now receiving quite a good number of orders, and some of them are stated to have as much as six months' work in hand. The position is far otherwise as regards the foundries in this district, which specialise in a lighter class of product for the many related industries around them. It is in the constructional engineering branches that the improvement in this area is noticeable. In most branches of this industry the volume of business has of late increased. True, the business which is passing is very unequally distributed, so that while one establishment may be pretty fully employed its neighbours find difficulty in maintaining half pressure. This is the position in the railway wagon building shops around Birmingham. Wagon builders are becoming busier, and quite an active trade is being done in the way of repairs. It is generally believed that the home railways must soon come into the market for rolling stock, some of the present vehicles being quite worn out and insufficient for trade requirements. Railway electrification is mainly responsible for such orders as are at present being dealt with on home account. There is an expanding demand for constructional material. One recent contract placed with a Northern firm by a foreign railway will, it is said, call for 9000 tons of steel. If buying continues to grow, if only on foreign account, it should favourably influence employment in this district before very long.

Midland Blast Furnaces Blown Out.

The local consumption of pig iron, though it is stated on some hands to be gradually improving, is still inconsistent with any market recovery. The inflow of orders is so precarious that practically no headway has been made towards establishing a sound relation between production costs and selling prices. The advance of coke values, moreover, has been a serious blow to the pig iron industry, makers in this area finding it impossible to get any relative advance from consumers of pig iron. So unsatisfactory has the position become that Alfred Hickman, Limited, of Spring Vale, Bilston, have decided, because of the poor prospect of the furnaces paying their way in existing conditions, to blow out two furnaces, one in South Staffordshire, and one at Corby, Northamptonshire. It was at first announced that only one furnace was to be stopped, but the intimation given in this letter a fortnight ago that two might be dispensed with has been justified by the events. The engineering trades are still but poor cutomers for pig iron, and the Staffordshire forges continue in a very stagnant condition. Some buyers of pig iron are now, however, investing in 50-ton lots instead of 10-ton lots, which for some time past has represented the limit of their enterprise. A few inquiries continue to come into this district from America, but Midland furnaces, generally speaking, find it practically hopeless to quote against producers on the coast. American inquiries are extending into the New Year and onwards to April. Whatever comes of them, these feelers on the part of American importers offset in some measure the unsatisfactory position in our domestic market. Within the past few days some very satisfactory inquiries have been received for supplies of hematite material, which, although likely to be sent from the West Coast, are being negotiated by Birmingham merchants.

Belgium and the Nut and Bolt Trade.

The Staffordshire manufactured iron trade is unfortunately in such an unenviable position just now that two ironworks which were recently re-started after a long spell of idleness have had again to be stopped owing to the inability to make ends meet. On a large proportion of the material turned out, it is stated, a loss of £1 per ton was sustained. Finished material is not being contracted for on generous lines, and consumers' needs are small. Staffordshire and Lancashire mills are in great difficulty as to the arrangement of rolling programmes. Nut and bolt makers are again buying less English material. The reason is not far to seek. Belgian shippers are willing to deliver nut and bolt iron in the Black Country at £8 7s. 6d. to £8 10s. per ton. Staffordshire houses that cater for this market quote £9 15s. to £9 17s. 6d. Consequently, continental makers are getting a relatively large amount of the business passing. Moreover, steel bars can now be bought as low as £8 15s., and where circumstances permit, they are being used instead of iron, for price is the ruling factor. Iron strip commands £10 10s. to £10 15s., which is 10s. to 12s. 6d. above the price of steel strip.

Sheet Values.

There is considerable activity in the sheet trade. The preference appears to be for thinner gauges, mainly for motor building requirements. Makers of galvanised sheets are again paving the way for an advance in prices. A few weeks ago the quotation soared to £16 15s. for 24 gauge corrugateds, but it receded to £16 5s. This week once more it has risen to £16 10s. to £16 15s. The policy of makers is a good deal criticised, especially as they have not been able, latterly, to apply these nominal advances. It is difficult to justify the step in the present sluggish state of the market. Orders are decidedly on the small side, the only compensation being the fact that they are steady and fairly widespread, and good inquiries are coming forward from overseas markets. Consumers at home, it is said, propose to test the market by keeping back their orders. Lead-coated sheets to 20 gauge have been reduced by £1 per ton, viz., from £28 to £27. The Tinned Sheet Manufacturers' Association has reaffirmed prices for the current quarter at 56s. per cwt. for best charcoal to 20 gauge, 54s. for charcoal, and 50s. for unassorted grade.

Steel.

There is very little animation in the steel trade, and prices are the subject of keen competition. Bedstead angles continue to be sold at cutting prices, which, it is stated, can hardly carry a profit. Bar prices do not appear to be too well assured at a minimum of £8 15s. The district quotation of £11 10s. for hoops has been undercut to the extent of 10s. The rock bottom price for billets is said to have fallen in exceptional cases below £6 17s. 6d. Some makers, however, value their product at £7 to £7 2s. 6d., even in the present state of the market. Foreign billets can be imported at about £6 13s. 6d., and a certain amount is coming into the district. Foreign competition is not, however, serious just now. Most of the Belgian steel offered is at prices almost equal to the home quotations, and, therefore, presents no pecuniary advantage. Very few consumers care to wait the five or six weeks now required by the Belgian steelmakers to give delivery, whether of finished or semi-finished material. Alfred Hickman, Limited, Spring Vale Steel Works, are about to reconstruct their 26in. and 36in. mills, and have this week given a week's notice to several hundred of their men. The work will take some time to accomplish, but it is anticipated that the men will eventually be found some kind of employment.

Nut and Bolt Workers' Wages.

The Darlaston Nut and Bolt Manufacturers' Association has given notice that the members will take a further 4s. a week off the 16s. bonus on piece rates on October 24th. This reduces the percentage on the piece rates from 60 per cent. to 50 per cent. Present average piece workers' earnings are 48s. per week.

LANCASHIRE.

(From our own Correspondents.)

Manchester, Thursday.

General Outlook.

A good deal of attention has been taken away from business questions this week by the political disturbance. Trade in the Manchester district was quite sufficiently restricted when it was thought that no election was probable before next spring or summer; but now it is smaller in volume than it was before, and a good many inquiries for material seem to have been withdrawn. The general trend of prices, however, especially in iron and steel, remains fairly steady. The tendency towards a further fall is held in check by the obvious fact that there is no satisfactory profit to be made out of the manufacture of iron and steel in this district. The state of demand certainly suggests a lower range of prices, but the costs of manufacture have to be brought down, and this is a difficult matter.

Metals.

The last attempt to raise the price of copper, originating no doubt with America, has failed, just as so many previous attempts have failed, and this gives further support to the belief that the time has not yet come when any upward movement in copper can be a success. It is a curious fact that best select copper, which has been maintained at one price for the last three months amid all the fluctuations of standard and electrolytic, has now been reduced by £1 per ton, as a result of the futile attempt to get more for standard and American refined metal. No doubt, the further rise in the value of sterling as computed in dollars has helped to prevent American copper prices from moving upwards here, but the general conditions of trade all over the world are still unfavourable to any upward movement, and it is these general conditions which call urgently for improvement, and not prices. The statistical position of copper in America is thought to be more favourable than it was, but it is not yet clear which is now growing faster, production or consumption. There seems, however, to be no doubt that South American production is tending towards considerable increase. In the markets for manufactured copper and brass there is no change, so far as the official prices are concerned; but the demand is poor, and one cannot see how it can fail to be restricted so long as the prices are kept at a level which consumers unanimously consider to be both unnecessary and unfair. Some surprise seems to be expressed that the Indian demand for manufactured copper and yellow metal is so poor, but it would certainly be surprising if Indian buyers were eager to pay the prices demanded, either for copper or for yellow metal sheets. The market for tin has been again very firm, and the highest prices of the year so far have now been reached. The closing price of last year was £170 10s. per ton for prompt and £172 10s. for forward, and the lowest price since then occurred in February. Some people are thinking that the upward movement has now gone far enough, and if it should be forced farther there will probably be an attempt to get out a "bear" account. It is true that people are talking very confidently of a further great rise in tin, but we have heard this kind of talk before, when those in the inner circle were about to speculate for a fall. Lead has been a strong market, but recently there have been signs of a disposition to take advantage of the higher prices. Spelter is also very firm, and as there is now rather a better trade demand, the position of this metal seems fairly secure.

Pig Iron.

The markets here for foundry pig iron are quiet and steady, and there has been very little change in the situation for quite a long time, except that buyers of Midland foundry iron are more satisfied that the prices are stable and are placing their orders further forward, some of them up to the end of January. This does not give the speculative seller much chance, however, because there seems to be not much probability of any fall in the Midland prices. If he could sell Cleveland over January, February and March next year at present prices there might be a good chance for him, for the causes which have led to the advance in Cleveland are almost bound to disappear by the end of the year. There is, however, no Cleveland iron being sold here, either for prompt or forward, and very little Scotch. The latter is quoted at £6 per ton against £4 10s. for common Derbyshire No. 3, so that the difference, which at one time reached £2 per ton, is now only £1 10s.; but it is still far too much, and the ordinary ironfounder cannot afford to pay it. American buying seems now to be affecting the East Coast hematite prices, and the last quotation for mixed numbers was 95s. At this price hematite is still about 7s. 6d. to 10s. per ton cheaper than Scotch when delivered in Manchester, but the difference is not nearly so tempting as it was.

Finished Steel.

The market here is very quiet, and one does not now expect to see any improvement before the beginning of the new year. Orders coming in are mostly for small quantities, and, of course, at prices which leave no profit to the manufacturer. The prices for finished steel reported from the Continent are again very low, probably partly in consequence of the fall in the exchanges; but the competition of foreign steel does not seem to reach as far as Manchester, although there is plenty of it in the Birmingham district.

Scrap.

Dealers in scrap are still grumbling at the prices at which they are compelled to sell. Cast scrap seems now to be the only ferrous scrap which it pays to handle, and then it must be bought very cheap. The selling prices here range from 75s. to 80s. for good lots, and up to 85s. for best lots of textile scrap. The prices for wrought iron and steel scrap are unchanged.

The Engineering Industry and the Election.

It is unfortunate for the general trade of the country and for the engineering industry in particular that the thoughts of everybody for the next three weeks or so are to be diverted more or less from trade to politics. It is particularly unfortunate for the engineering trade, because in many directions there have recently been slight signs which it was hoped were the beginnings of a slow but permanent amelioration. With labour troubles cleared away and an evident determination to "get a move on," the outlook until a few days ago was more promising than it had been for a long time past. Still, it is generally agreed that, granted the necessity for a general election, it is better that it should take place at the earliest possible date rather than be postponed indefinitely. Lancashire takes its politics seriously, more so perhaps than many other industrial centres, and trade cannot fail to suffer in consequence. Party feeling, however, is not nearly so bitter in Lancashire as it was before the war. The predominant desire of the more responsible section of the public is for a Government free from reactionary tendencies, and one which will recognise the vital necessity of strict economy, and will devise means to restart the wheels of industry upon which the future of this great trading community depends. The reduction of the income tax is urgently needed, and our foreign trade must be developed with the utmost energy, but this cannot be done until means are adopted for improving and stabilising the foreign rates of exchange. Turning from economics to engineering, it is satisfactory to note that a revival of industry is about to take place at Crewe, where an order for thirty powerful locomotives, at an approximate cost of £15,000 each, is about to be put in hand, together with an order for a number of new boilers. These will find employment for a large number of workpeople for some time to come, and will have a beneficial influence on the machine tool and metal trades. There is still a fair amount of work in hand in the textile machinery shops, and a prospect of a slight revival in the local motor car industry. Mirrlees, Bickerton and Day, at Hazel Grove, are busy on Diesel engines. Among machine tool makers, Kendall and Gent have a considerable amount of work in hand, while the local heavy electrical power plant builders have little to complain of. In spite of this, however, there are still over 30,000 persons in Manchester for whom there is no employment, and a large proportion of these have been stopped by engineering firms owing to slackness.

Barrow-in-Furness, Thursday.

Hematite.

The demand for hematite pig iron continues to be steady with good prospects for the future. The output now that the furnace at Carnforth has been started is increased. It is not likely that there will be any additions to the present number of furnaces active in this district until later in the year when the trade is expected to improve considerably. The inquiries which are coming in are for larger quantities, and the trade in special qualities of iron for engineers is increasing. The Continent continues to be a good customer, and this trade will further increase as time goes on. The stocks held by makers are being depleted, and in some cases there are practically no stocks at all. Scotland is improving every week as a customer, and Sheffield and the Midlands are also developing as regards more trade. The steel departments are fairly large consumers of iron, and it may be safely said that if trade shows a sudden increase in demand there will have to be a bigger output. Altogether, one can view the prospects of the hematite pig iron with confidence.

Iron Ore.

The iron ore trade is improving. There is a bigger local demand in view of the increase in the number

of furnaces, and there is also a development of the trade with smelters in other parts. There are now deliveries to various parts by rail and sea, and Hodbarrow is developing the sea-borne trade. Foreign ore is not coming in in large quantities yet, as there are stocks laying at the docks to clear, but these are being gradually reduced.

Steel.

Taking everything into consideration, the steel trade is doing fairly well. It is hoped there will be further orders booked in the early future, for those held at present will not carry the works far. The Workington rail mills are working this week, and Barrow has still its rail, merchant and hoop mills engaged. A part cargo of rails was dispatched from Barrow last week for Port Harcourt, West Africa, *viâ* Liverpool. Foundries are only moderately employed.

Shipbuilding and Engineering.

There are no developments in the shipbuilding and engineering trades as yet, but a better feeling of confidence prevails in certain circles. When the wage question and the taking off of the bonus have been decided there will be better news to communicate probably. Barrow was disappointed at not getting the order for the Southampton floating dock. There was some very keen cutting in prices, the margin for profit being practically eliminated.

SHEFFIELD.

(From our own Correspondent.)

Slow Recovery of Heavy Steel.

Writing about the progress of the heavy steel trade of Sheffield is rather disheartening work, for although that progress can be seen, it is a very slow business, and put the best face on the matter though we may, the fact remains that conditions are still very unsatisfactory. In the recovery of her trade, Sheffield is not by any means keeping pace with other important industrial centres, and the state of depression which exists here is one of the worst in the country. Still, there is ground for hope. Some branches are better, and there is a constant stream of inquiries, which shows how widespread are the requirements for Sheffield products. If only an average proportion of these inquiries resulted in actual business, the works would be active again at once, but unfortunately this is not the case, as the orders which do come forward are on a most disappointingly small scale. There is a good number of inquiries on hand for railway material, for both the home and Indian companies, and the volume of business in this department is expected to expand. A few good orders have been received from the shipyards for forgings and castings, but the quantity is very small compared with the productive capacity of the city. The news that the Admiralty has at last asked for tenders for the two new battleships is very welcome in Sheffield. Persistent efforts have been put forward throughout the year to get the Government to expedite the construction of these vessels, but such efforts have failed so often that hope had almost vanished. Two Sheffield firms—Vickers Limited, and Cammell Laird and Co., Limited—are among those which have been asked to tender, and it is fully expected that a substantial amount of work will be secured for the city. The total expenditure on the two vessels is stated to be £12,000,000, two-thirds of which will be spent in wages.

Basic Steel Doing Well.

The strongest side of the steel trade is that dealing with basic material. There is quite a brisk request for billets of this variety, and some of the contracts, coming from overseas, are so urgent that double shifts are being worked in order to execute them. Such cases are, of course, rare. There is a good deal of activity in the lower grades of mild steel, steel strip, and colliery tools, but acid qualities are still in very poor request. The foundries, forges, railway departments, and mills working for hire are still on very short time. Business is very slack with the makers of saws, edge tools, and various tools used in engineering and quarrying work. On the other hand, the electrical departments are not badly employed. Australia and other countries are requiring materials for power schemes. Sheffield has laid itself out a good deal to develop the electrical engineering trades, and there is much confidence in their future. There is little improvement to report in the crucible steel trade. The home demand for this important material is very quiet, and the effects of the Fordney Tariff, though not quite so bad as as some people feared at first, are still serious.

The Reopening of Russia.

There is no country in Europe which is more capable of helping some of Sheffield's trades than Russia. She needs vast quantities of steel goods for use in her forests and great agricultural areas, and has for many years been one of the city's best customers, some of her orders being on an amazing scale. The trade was, of course, cut off by the war, and the disturbed state of the great country since then has been a barrier to any recovery. Still, a few orders have come through occasionally, and, as things get settled, there is a prospect of many more. There is some cheering news from this source just now. An order for several thousand long timber saws has just been executed, and it is a tribute to the capacity of Sheffield that the whole quantity was supplied by one firm out of stock. Negotiations are now in progress with buyers, on behalf of the Soviet Government, for further and larger quantities of saws, files, and a variety of tools. Some half-dozen houses in Sheffield have reaped very considerable benefit from Russian business since the war. It is satisfactory to know that the terms agreed upon in all these transactions are cash down, and that no trouble is experienced on the score of obtaining payment.

Opposition to Smoke Bill.

The attack on black smoke, made in the Smoke Abatement Bill promoted by the Ministry of Health, is causing serious disquietude to Sheffield steel manufacturers. It has been urged for many years by steel experts of the city, that black smoke is essential to the production of their high-class material, and they are again putting forward this view with all their power. A report has been drawn up by the Chamber of Commerce, Engineering Trades Employers' Association, Crucible Steel Makers' Association, Rolling Mill Proprietors' Association, and Forgers' and Tilters' Association—a combination which ought to carry weight—in which the reasons for this opinion are clearly set out. It is claimed that high carbon steels cannot be satisfactorily dealt with in smokeless furnaces, either for forging, rolling, or annealing, and that there is no known process for heating steel sheets for high-class finish which avoids a certain amount of black smoke. It is pointed out that a smoky atmosphere does not decarburise the surface of the steel, whereas a clear flame will do so, and render the material useless for the purpose for which it is required. The substitution of excess gas in a gas-fired furnace has been proposed in order to reduce the smoke trouble, but the Sheffield manufacturers claim that attempts in this direction have proved failures, and will continue to do so with present-day knowledge and with the staff and workmen at their disposal. They strongly urge that the passing of the Bill would have the effect of shutting down the whole of some important plants in Sheffield, and they claim exemption as regards black smoke from all furnaces dealing with high carbon, high-speed, and alloy steels, and all high-class steel sheets. They also totally oppose the other clauses of the Bill, which include smoke other than black, together with offensive gases, soot, ash, grit and gritty particles, on the ground that if these clauses became law no chimney in the district would be exempt.

Stainless Cutlery in Demand.

The only healthy branch of the cutlery trade for some time has been that dealing with table knives, and the activity on this side continues to grow. The word "boom" is not too strong to apply to the stainless cutlery trade, but there are so many firms engaged in it that the demand is still hardly sufficient to make itself universally felt, and some of the largest firms could do with more orders on their books. The makers of handles are doing a roaring business, and state that their sales exceed those which they were accustomed to in pre-war times at this period of the year. The Colonies are buying stainless knives well, especially Canada and Australia, from which good orders have been received during the past week. The pen and pocket knife department does not improve much, but there is a better outlook in the scissors section. The electroplate trade fully maintains its increased activity. The Christmas demand is on a very large scale, and some factories have had to introduce night and day shifts in order to ensure early delivery. It is complained, however, that much of the business is not very profitable, as the big buyers are very keen on getting the lowest quotations.

Some New Departures.

Interesting innovations in the Sheffield trades are frequently coming forward, and there has been quite a good crop of them this week. The British Cutlery Research Association has held an exhibition of modern methods as applied to the cutlery trade, the exhibits including the latest machines for use in the manufacture of pocket knives, table knives, razors, and scissors. Special attention was devoted to machine grinding and polishing of blades, and the machine production of handles. A novel departure that has just been introduced into the trade is the use of electric welding for attaching table-knife blades to steel handles. The knives have hollow handles and are without bolsters, but are so constructed as to secure balance and lightness. They are produced and ground by machinery, and are characterised by durability, good appearance, and low price. In the plating department, an important development is the discovery of a method of electro-plating silver, copper, nickel, iron and steel with chromium. It is claimed by a local firm that it has evolved a process whereby chromium can be utilised commercially for plating many kinds of goods, such as knife blades and handles, spoons and forks and other table ware. Chromium will neither rust nor stain, and also possesses the property of hardness.

Local Colliery Development.

The extension of the colliery industry in South Yorkshire and North Nottinghamshire has by no means come to a stop yet; in fact, there are so many schemes on hand, and so many good prospects, that one might almost say developments are still in their infancy. At Brodsworth Main, near Doncaster, it has been decided to sink a third shaft to the Barnsley seam, which lies at a depth of about 600 yards. The object of this enterprise is to facilitate output and secure something like 32,000 tons a week. Good progress is being made by Messrs. Barber, Walker and Co. with the sinking of Harworth Main colliery, both shafts having now reached a depth of over 400 yards. During the past week a second seam of coal, about 3ft. 6in. thick, has been gone through. There is a prospect of an immediate resumption of operations to develop the Rampton and Leverton coal scheme. Mr. J. P. Houfton, of Mansfield, in a speech last week, dwelt most optimistically on the colliery future of the district. He considers that for the next 150 years or more Mansfield will be a flourishing centre of the mining industry. The top hard seam is being worked at Mansfield at present, but Mr. Houfton points out that the deep hard and deep soft, which lie beneath the top hard, are being worked at other places in the district, and he considers that in the future these seams, as well as the Tupton Ell coal and the black shale, will be found at workable thickness in the Mansfield area. These large seams consist principally of soft bright coal, and pits which are sunk or deepened to win them will have to be equipped with coke ovens. Mr. Houfton added that large and influential colliery companies have taken over leases of coalfields within ten miles of the town, and developments are to be commenced almost immediately at Ollerton and Bilsthorpe. These collieries will be developed within the next ten years, and will probably employ 10,000 men, representing an increased population of the district of 30,000 to 40,000. It is expected that at least 1000 houses will be built at the new Clipstone Colliery, and this will represent 5000 people in the next two or three years. Mr. Houfton is very largely interested in colliery enterprise in the Mansfield district, and speaks with authority, so that his views are of exceptional interest.

Personalia.

An appointment of great local interest is that of Dr. Percy Longmuir to the post of director of research to the British Cast Iron Research Association. Dr. Longmuir is recognised as one of the foremost experts in cast iron. He has had a long and successful record in Sheffield, where, after a brilliant career at the University, he has held several important works appointments. He has been President of the Institution of British Foundrymen, and is the President of the Foundry Trades Technical Society, which has recently been established in the city. Mr. Frederick Best, secretary and director of Thomas Firth and Sons, Limited, one of the best-known commercial men in Sheffield, has been appointed commercial manager for Bolckow, Vaughan and Co., Limited, of Middlesbrough.

NORTH OF ENGLAND.

(From our own Correspondent.)

Trade and the Political Crisis.

Political crises invariably affect all branches of commerce, and the present is not likely to prove the exception. Until the election is completed a tendency to withhold orders will probably become increasingly marked. Business men, however, are hoping that the new Parliament will be marked by a real effort at retrenchment, and the reduction of national expenditure to more reasonable limits. In many directions business is already suspended, and buyers generally are inclined to move with caution.

Cleveland Iron Trade.

There is a much quieter tone in the Cleveland iron trade, due largely to the political upheaval, but ironmasters are well situated for orders, and can afford to view the outlook with some measure of equanimity. American inquiries for foundry iron appear to have fallen away, but that is regarded as only a temporary lapse, and as the shortage of supplies across the Atlantic still continues, it is expected that American consumers will continue to absorb big quantities of Cleveland iron until the end of the year. Prices are consequently firm, but that fact operates against any expansion of the home trade. Home foundries are busier, but they cannot afford to pay 92s. 6d. per ton for Cleveland iron, and are buying from the Midlands and also from the Continent. The fall in the Belgian, French and German exchanges all tells against the local producer. It limits the continental demand for our iron, and it enables continental producers to compete for business in the home market, which they are now doing successfully. Still, with coke at 31s. per ton, ironmasters are not in a position to cut prices, and all quotations are unchanged, as follows:—No. 1 and siliceous iron, 97s. 6d.; No. 3 G.M.B., 92s. 6d.; No. 4 foundry, 90s.; and No. 4 forge, 85s.

Hematite Pig Iron.

There is not much change in the East Coast hematite pig iron trade. A few inquiries are still coming forward from America, though perhaps not quite so much business. Makers, however, are well sold, and are not in a position to quote for immediate delivery. East Coast mixed numbers remain at 92s. 6d. per ton and No. 1 at 93s. per ton.

Iron-making Materials.

The foreign demand for coke seems to be falling off, and hopes are reviving that prices will become easier. Certainly there is urgent need for a cut in coke prices if the iron trade is to survive, and some of the coke makers, realising that their ultimate prosperity is linked up with the iron trade, prefer to accept less than market rates from the ironworks rather than neglect old clients in order to take advantage of the boom rates in the export trade. Good medium furnace qualities of coke are 31s. per ton delivered at the works. There is a small business passing in the foreign ore trade, but only at cut rates, and best Rubio is offered at 23s. per ton, c.i.f. Tees.

Manufactured Iron and Steel.

In the steel trade business shows very little improvement, and the plant operating is not fully employed. Still, a few more orders are coming along, and makers, having got to rock bottom, are not inclined to cut prices further. There are a few cheap billets in the market, but first-rate qualities still maintain their price.

Shipbuilding.

Greater activity is foreshadowed in the shipbuilding trade in the near future. A number of inquiries for new tonnage are circulating, and this week Smith's Dock Company, South Bank, has secured an order for two fairly large steamers which are to be built for trading on the Canadian lakes.

The Coal Trade.

The Northern coal market remains very firm in every direction, and continues to be supplied in all sections of the trade by a well sustained and varied inquiry, both for spot and also for forward, in some cases as far ahead as the end of next year. Contracting ahead, however, is

not very brisk. This is not to be wondered at, seeing that the present range of high values is holding up, and gives promise of continuance for some little time yet. The inquiries from abroad are not so numerous just at the moment, with the exception of Germany, which is the mainstay of the export trade, and continues to absorb vast quantities of all classes of coal from North-Eastern ports. The home trade inquiries are fuller, and the home market appears to be livening up, and is expected to continue expanding from now onwards. The spot position is not exactly as tight as it was. Odd lots of coal are on offer, but with the loading turns remaining so congested and difficult, they are not quite so keenly taken up as was the case a few weeks ago. Contracts are reported to have been placed by a firm of exporters for second-class gas coking and unscreened Durham steams of good ordinary brands, about 200,000 tons, at an average price of 21s. per ton f.o.b., with shipment to France over the whole of next year. This is considered to be a very good average price, having regard to present values, and is likely to form some guide as to values for next year's contracts, though some people regard the price as being remarkably cheap under the circumstances. Best Northumberland steams are at top figures, with steam smalls considerably firmer and moving upwards in price. Brands of small steams, such as Tyne primes, as well as Broomhills, have been sold several times direct as high as 17s. per ton f.o.b. Gas coals are very firm for every class, either prompt or forward, business being only possible on the basis of full quotations. Coking coals are scarce and strong, with bunkers strongly supported at top prices. The coke market remains very steady, with a fairly heavy demand and stocks low. Values retain all their strength and rigidity, with no possibility of breaking the prices ruling.

SCOTLAND.

(From our own Correspondent.)

Better Export Prospects.

Conditions are not such as to promote enthusiasm, but a slightly better feeling exists with regard to export business. Home markets give no sign of improvement, and producers more than ever are looking to overseas markets. At the moment the latter appear to be more energetic, though as yet inquiries are far more prominent than firm orders. Here and there, however, business is being picked up, and there is evidence of more to follow if suitable terms can be arranged.

New Contracts.

In these days even the smallest contract is of interest, while one of respectable dimensions is an event. It is reported that the Clyde Shipping Company has placed an order for a new steamer with Alex. Stephen and Sons, Linthouse. The vessel is of small tonnage, but is nevertheless a welcome addition to contracts recently announced. In respect to engineering contracts it is announced that John Cochrane (Barrhead), Limited, Barrhead, have secured the contract to supply, to the order of the London Metropolitan Water Board, a complete pumping installation for Eynsford pumping station. This firm also has on hand contracts for an electrically driven sewage pumping station for Portsmouth Corporation, and a pumping installation for Chichester Corporation waterworks.

Pig Iron.

In the meantime the production of pig iron is well absorbed. The home market is taking next to nothing, but good shipments are still being dispatched to America against contracts. With the end of the American orders in sight conditions would appear to be returning to their former dulness and quotations are consequently showing a slightly easier tendency. The American contracts may take the bulk of the outputs for some weeks yet, but the need of new business is becoming more persistent, especially since more furnaces have been put in blast.

Steel and Iron.

The dulness in the steel and iron trades shows small sign of lifting. The steel works remain particularly short of orders for plates, while the demand for sections has diminished. Black sheets, also, have slackened off, and galvanised varieties have dropped by 20s. per ton within the past fortnight. Inquiries are plentiful enough, but producers find business increasingly difficult to conclude. Consumers are convinced that it is expedient to wait until all wages discussions are settled before launching out on an extensive scale, and present purchasing is cut down to the lowest possible minimum. Manufactured iron is in no better plight, and the works are only getting a small percentage of employment. Bar iron is picking up day-to-day lots and makers can rarely see a few days ahead. Tube makers are in a slightly better position, and further improvement is looked for. Scrap material remains dear.

Coal Trade Active.

The tone in the Scotch coal trade in general is more satisfactory. The collieries are comparatively well off for business and demands are expanding in various directions. Fair orders are in hand for dispatch to Canada and fresh orders from America are reported. Round coal and washed double nuts are mentioned in this connection. Considerable pressure exists for prompt supplies of best ells, and firm prices are obtained. A good turnover in both round fuel and washed material is being done for shipment to continental destinations. Prices for shipment are very firm. Stemming difficulties are being met with and shipping returns are down, amounting to 290,910 tons in the past week, against 337,657 tons in the preceding week and 330,072 tons in the same week in 1913. There is not much improvement in local business. Industrial demands are not growing, and house coal alone shows any increase in turnover.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Outlook.

Although last week the volume of the foreign export business displayed a falling off, still the tone is better, and the prospects for the remainder of this year are very good. Most of the leading collieries are fully sold for the rest of this month and the whole of November, while it is also the case that some of them have stemmed a good number of steamers for December loading. Altogether the demand is fairly active, although operations for Italy for November shipment are at the moment rather quiet. Negotiations are also proceeding for the export of further supplies to America and Canada. According to Mr. H. H. Merrett, principal of D. R. Llewellyn, Merrett, and Price, Limited, of Cardiff, who has just returned from the States, the American coal position generally is far from settled, and there are considerable difficulties to be overcome between now and March 31st next if a further strike in the bituminous coalfields is to be avoided. There is very little hope at the present time of an arrangement being come to, and it is possible that a further serious conflict will be seen between the American operators and workers. Mr. Merrett further points out that the shortage of domestic coals so far as the coming winter is concerned is approximately forty million tons, and even if the normal output of anthracite were obtained the deficiency is so great that there will not be sufficient to go round. If the railroad position could be improved the productive capacity of the bituminous mines is so great that unlimited quantities could be produced, but this development will be retarded for a very long period, as the rail position is hopeless.

Non-unionist Notices: A Fiasco.

Any serious trouble that might have been expected as the result of the decision of the Executive Council of the South Wales Miners' Federation that miners throughout the coalfield should tender fourteen days' notices to terminate their contracts on Monday last is now very largely discounted when it is seen to what extent the instruction has been acted upon. It is very evident that the leaders have misjudged the feeling of the workmen, many of whom have for months been either idle or working short time and cannot see the wisdom of striking and thus further jeopardising their employment prospects. So far as can be gathered, fully 60 per cent. of the workmen have refrained from handing in their notices, so that the coalfield conference which is to be held on Saturday next will have to reconsider its attitude, and it is not unlikely that it will be decided that the notices shall be withdrawn. In some of the districts the miners have ignored the instructions of their leaders completely, notably at some of the collieries in the Rhondda and in Monmouthshire, while at others the percentage of notices served ranged from 10 to 25, and in isolated instances from 80 to 90 per cent. It is, of course, impossible to say what proportion of abstentions represents non-unionists, and it must be remembered that safety men and those who are employed in maintaining the mines were ordered by the Federation not to tender their notices. Furthermore, the members of the Colliery Examiners' Association, the Surface and Mechanical Workers' Union, and the Winding Enginemen's Union were also given the same instructions. Independently of the instructions sent out by the South Wales Miners' Federation, the members of the South Wales and Monmouthshire Mechanical and Surface Workers' Union were told by their Executive not to hand in their notices, but to stand fast and not give way to bluff, which is the description applied to the threat of the Miners' Federation. Some of the leaders of the Mechanical and Surface Workers' Union are of the opinion that the movement on the part of the Miners' Federation is nothing but a political one. Probably the leaders of the Miners' Federation will make the developments in the political world an excuse for the withdrawal of the notices that have been served.

Railway and Dock Charges.

Members of the deputation representing the South Wales coal exporters and coalowners which recently saw the general manager of the Great Western Railway with reference to railway rates and dock charges have had a further interview with Mr. Felix Pole. Their purpose was to ascertain the precise position in regard to the concession offered by the Great Western Company, in view of the fact that they propose making an application to the Railway Rates Tribunal on the matter as they are not satisfied with the concessions offered by the company. The railway companies propose to apply for the continuation for a further period of the Temporary Increases of Charges Act, which, unless renewed, will expire next year. Unless parliamentary prolongation of the Act is secured, the railway companies will be unable to charge higher rates than those sanctioned by the powers they held before the war. The traders have to give notice by November 1st whether they will apply to the Rates Advisory Committee for a reduction or whether they will oppose any application by the Great Western Company for an order giving it authority to continue the existing charges.

Current Business.

Very steady conditions prevail in the steam coal market, and with tonnage coming along pretty freely, collieries are for the most part well placed for some weeks ahead. This is especially the case with the superior coals, and while the majority of the collieries producing them are quoting 27s. 6d. to 28s., some of them are so fully sold that it is very doubtful whether supplies for anything like early loading can be secured at these figures. Second Admiralty large coals are quoted at 27s. to 27s. 6d., and leading Monmouthshire large qualities up to 26s. 6d. Best small coals are worth 16s. to 17s., but patent fuel and coke display no change of importance. The demand for all classes of anthracite is very good, and prices are firm.

Swansea Metal Exchange.

The arrangement between tin-plate makers and bar steel makers fixing a minimum price for tin-plates has already had a strengthening effect upon the market, and business has been more active. The inquiry is on a widespread scale.

Ebbw Vale Dispute Settled.

The Ebbw Vale dispute has been settled, as the outcome of a conference between representatives of the coalowners and the miners' leaders, who met unofficially to discuss the position as the result of a suggestion made by Mr. Evan Williams, the chairman of the Conciliation Board. Work is to be restarted on Monday, but it will be some time before this can be on a full scale, especially so far as the steel works are concerned, as the furnace fires have been raked out, and it is necessary to have the furnaces re-lined. Efforts are, however, to be made to expedite matters. A mass meeting of the miners is being held to-day to hear an official statement from their leaders on the position.

LAUNCHES AND TRIAL TRIPS.

Spotbill, hopper barge; built by Lobnitz and Co., Limited, to the order of the Bombay Port Trust; to carry 800 tons; completed successful trials and was handed to owners on August 25th.

Hopper Barge No. 25; built by the Monmouth Shipbuilding Company, Limited, to the order of the Port of London Authority; dimensions, 215ft. by 35ft. 6in. by 19ft. 3in. Engines constructed by the Fairfield Shipbuilding and Engineering Company, Limited; trial trip, September 13th.

San Manuel, oil tank steamer; built by Palmer's Shipbuilding and Iron Company, Limited, to the order of the Eagle Oil Transport Company, Limited; dimensions, 422ft. by 52ft. 4in. by 31ft. 6in.; to carry 8250 tons deadweight. Engines, triple-expansion, 27½in., 46in., 77in. by 48in. stroke, pressure 180 lb.; constructed by the builders; launch, September 20th.

Invergoil, "N" standard vessel; built by Harland and Wolff, Limited, to the order of the British Mexican Petroleum Company, Limited; dimensions, 428ft. by 55ft. 5in. by 38ft.; to carry 6900 gross tonnage. Engines, triple-expansion. Launch September 21st.

Merioxes, steel screw passenger and cargo steamer; built by Palmer's Shipbuilding and Iron Company, Limited, to the order of the Ocean Steamship Company, Limited; dimensions, 476ft. 6in. by 58ft. by 35ft. 3in.; to carry 10,000 tons deadweight. Engines, single-screw double reduction geared turbines, pressure 220 lb.; constructed by the builders; trial trip, September 22nd.

San Roberto, steel tank steamer; built by Sir W. G. Armstrong, Whitworth and Co., Limited, to the order of the Eagle Oil Transport Company. Engines, triple-expansion, pressure 180 lb.; constructed by the Wallsend Slipway and Engineering Company, Limited; trial trip, September 19th.

Steel Screw Hopper Barge No. 26; built by the Monmouth Shipbuilding Company, Limited, to the order of the Port of London Authority; dimensions, 215ft. by 35ft. 6in. by 19ft. 3in. Engines, triple-expansion surface condensing, pressure 180 lb.; constructed by Fairfield's Shipbuilding and Engineering Company, Limited; launch, September 25th.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

Mr. Walter S. Hudson asks us to state that he has changed his address from The Green, Hellifield, to Low Hall, Kirkby Overblow, near Harrogate.

We are informed that Mr. W. M. Selvey's address, on and after November 1st, will be 66, Victoria-street, Westminster, S.W. 1, and the new telephone No. Victoria 264.

Fry's Metal Foundry, of 25–42, Holland-street, Blackfriars, London, S.E. 1, informs us that some time ago it took over the management of the Light Casting and Patternmaking Company, Limited, of Hillside Foundry, Kingsbury-road, Kingsbury, N.W. 9, and that recently it has purchased the whole of the plant and goodwill as a going concern.

The Institute of Marine Engineers.—The annual dinner of the Institute of Marine Engineers will be held at the Hotel Cecil on Friday, November 3rd, at 6.15 p.m.

Contracts.—The Cleethorpes Urban District Council has placed an order with the Walker-Weston Company, Limited, for the supply of that company's patented interlocked double-layer reinforcement, in connection with the reconstruction of the main Grimsby-road at Cleethorpes.

The Institute of Cost and Works Accountants.—We are asked to state that the Sessional Examinations of the Institute of Cost and Works Accountants will take place on December 4th, 5th and 11th, and will be held in London, Manchester, Birmingham, Sheffield, Glasgow and Bristol. Application should be made on Form "C," obtainable from the Secretary, 38, Grosvenor-gardens, at least 21 days before the date of examination.

A New Steam Trap.—A new form of the float type of steam trap, which has just been brought out by Wm. Geipel and Co., of Vulcan Works, St. Thomas-street, London, S.E. 1, is noteworthy on account of the care taken in its design to provide easy access to the working parts. The valve, which is of nickel and has a nickel seating, is arranged in a brass case on the top of the trap, and can be exposed by removing a screwed cap. The float lever, also, can be got at quite easily without breaking the cover joint of the float chamber. One of the claims made for the trap is the reduction of loss by radiation on account of its small overall dimensions.

The Optical Society.—The programme of the Optical Society for the current session includes the following lectures dealing with the evolution and development of optical instruments and apparatus:—"The History of the Photographic Lens," by Dr. R. S. Clay, on November 9th, 1922; "The Birth of Cinematography and its Antecedents," by Mr. Will Day, on January 25th, 1923; "Surveying and Nautical Instruments from a Historical Standpoint," by Dr. L. C. Martin, on March 22nd, 1923; and "Telescopes from a Historical Standpoint," by Mr. D. Baxandall, A.R.C.Sc., on May 24th, 1923. The lectures will, in each case, be illustrated by a series of unique instruments of historic interest from various collections. The meetings will be held at 7.30 p.m., on the dates specified, at the Imperial College of Science and Technology, South Kensington.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	22/6
(1) Spanish	22/6
(1) N. African	22/6
N.E. Coast—	
Native	—
Foreign (c.i.f.)	23/-

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	5 7 6	—
No. 1 Foundry	5 5 0	—
No. 3 Foundry	5 0 0	—
N.E. Coast—		
Hematite Mixed Nos.	4 12 6	4 12 6
No. 1	4 13 0	4 13 0
Cleveland—		
No. 1	4 17 6	4 17 6
Silicious Iron	4 17 6	4 17 6
No. 3 G.M.B.	4 12 6	4 12 6
No. 4 Foundry	4 10 0	4 10 0
No. 4 Forge	4 5 0	4 5 0
Mottled	4 0 0	4 0 0
White	4 0 0	4 0 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	13 0 0	—
North Staffs. Forge	3 12 6	—
,, ,, Foundry	4 4 0	—
(3) Northampton—		
Foundry No. 3	4 0 0	—
,, Forge	3 10 0	—
(3) Derbyshire—		
No. 3 Foundry	4 1 6 to 4 2 6	
Forge	3 17 6	—
(3) Lincolnshire—		
Basic	4 6 6	—
Foundry	4 6 6	—
Forge	4 6 6	—
(4) N.W. Coast—		
N. Lancs. and Cum.		
Hematite Mixed Nos.	5 5 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	10 10 0	10 10 0
Best ,,	12 0 0	—
N.E. Coast—		
Crown Bars	10 10 0	—
Tees	10 0 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	10 5 0	—
Hoops	14 0 0	13 15 0
S. Yorks.—		
Crown Bars	12 0 0	—
Best ,,	12 10 0	—
Hoops	14 0 0	—
Midlands—		
Crown Bars	10 10 0 to 11 0 0	
Marked Bars (Staffs.)	13 10 0	—
Nut and Bolt Bars	9 15 0 to 9 17 6	
Gas Tube Strip	10 10 0 to 10 15 0	

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	12 10 0	—
Ship Plates ¾in. and up	9 0 0	—
Sections	8 15 0	—
Steel Sheets ¼in. to ¾in.	10 5 0	—
Sheets (Gal. Cor. 24 B.G.)	—	16 12 6

STEEL (*continued*)

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	9 0 0 to 9 10 0	—
Angles	8 15 0 to 9 0 0	—
Boiler Plates	12 10 0	—
Joists	9 0 0	—
Heavy Rails	9 10 0	—
Fish-plates	14 10 0	—
Channels	13 10 0	—
Hard Billets	8 5 0	—
Soft Billets	7 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	9 10 0	—
Light ,,	11 0 0 to 13 0 0	
Billets	9 5 0	—
Manchester—		
Bars (Round)	9 0 0 to 9 10 0	
,, (others)	9 10 0 to 10 0 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	12 5 0	12 0 0
Plates	9 0 0 to 10 0	
,, (Lancs. Boiler)	13 10 0	—
Sheffield—		
Siemens Acid Billets	10 0 0	—
Bessemer Billets	12 10 0	—
Hard Basic	8 5 0	—
Soft ,,	7 5 0	—
Hoops	11 15 0	—
Soft Wire Rods	10 0 0	—
Midlands—		
Small Rolled Bars	8 15 0 to 9 0 0	
Billets and Sheet-bars	6 17 6 to 7 0 0	
Gas Tube Strip	10 0 0 to 10 5 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets (f.o.b. L'pool)	16 10 0 to 16 15 0	
Angles	8 15 0 to 9 0 0	
Joists	9 0 0 to 9 10 0	
Tees	10 0 0	—
Bridge and Tank Plates	9 0 0 to 9 10 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/3 to 19/4½
Block Tin (cash)	174 7 6
,, (three months)	175 2 6
Copper (cash)	63 0 0
,, (three months)	63 12 6
Spanish Lead (cash)	26 10 0
,, (three months)	25 5 0
Spelter (cash)	36 2 6
,, (three months)	34 15 0
Manchester—	
Copper, Best Selected Ingots	66 10 0
,, Electrolytic	71 0 0
,, Strong Sheets	96 0 0
,, Loco Tubes	0 1 1½
Brass Loco Tubes	0 0 11½
,, Condenser	0 1 2½
Lead, English	27 10 0
,, Foreign	26 7 6

FERRO ALLOYS.

(All prices now nominal.)

	Per Ton.	Per Unit
Tungsten Metal Powder	1/11 per lb.	
Ferro Tungsten	1/5 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£30	12/-
,, 6 p.c. to 8 p.c. ,,	£22 10 0	9/-
,, 8 p.c. to 10 p.c. ,,	£21 10 0	8/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£55 0 0	26/-
,, ,, 1 p.c. ,,	£68 0 0	30/-
,, ,, 0·75 p.c. carbon	£75 0 0	37 -
,, carbon free	1/7 per lb.	
Metallic Chromium	5/- per lb.	
Ferro Manganese (per ton)	£15 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£11 2 6 scale 5/- per unit	
,, ,, 75 p.c.	19 10 0 scale 6/- per unit	
,, Vanadium	17/- per lb.	
,, Molybdenum	8/- per lb.	
,, Titanium (carbon free)	1/2 per lb.	
Nickel (per ton)	£160	
Cobalt	11/- per lb.	
Aluminium (per ton)	£82 to £100	

(British Official.)

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	24/-
,, ,, Ell	25/-
,, ,, Splint	25/- to 27/6
,, ,, Trebles	23/6
,, ,, Doubles	21/9
,, ,, Singles	19/-
Ayrshire—	
(f.o.b. Ports)—Steam	24/-
,, ,, Splint	25/-
,, ,, Trebles	23/6
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	21/6 to 26/-
Screened Navigation	28/-
Trebles	24/-
Doubles	22/3
Singles	20/-
Lothians—	
(f.o.b. Leith)—Best Steam	24/-
Secondary Steam	23/-
Trebles	24/-
Doubles	22/3
Singles	20/6

ENGLAND.

(8) N.W. Coast—	
Steams	19/6
Household	46/8 to 57/6
Coke	34/-
Northumberland—	
Best Steams	26/- to 27/-
Second Steams	24/- to 24/6
Steam Smalls	15/- to 16/6
Unscreened	20/6
Household	25/- to 28/-
Durham—	
Best Gas	24/- to 24/6
Second	22/- to 22/6
Household	25/- to 28/-
Foundry Coke	37/- to 40/-
Sheffield—	Inland.
Best Hand-picked Branch	32/6 to 34/6 —
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	24/- to 25/- —
,, ,, House	21/6 to 22/6 —
,, ,, Large Nuts	18/6 to 20/6 —
,, ,, Small ,,	15/- to 16/6 —
Yorkshire Hards	20/- to 21/- —
Derbyshire ,,	19/- to 20/6 —
Rough Slacks	8/6 to 10/6 —
Nutty ,,	7/6 to 8/6 —
Smalls	3/- to 5/- —
Blast Furnace Coke (Inland and Export)	21/- to 30/-

(9) SOUTH WALES.

Cardiff—	
Steam Coals:	
Best Smokeless Large	27/6 to 28 6
Second ,, ,,	27/- to 27/6
Best Dry Large	28/- to 29/-
Ordinary Dry Large	27/6 to 28/-
Best Black Vein Large	25/6 to 26/6
Western Valley ,,	25/6 to 26/-
Best Eastern Valley Large	24/6 to 25/-
Ordinary ,, ,,	22/6 to 24/6
Best Steam Smalls	16/- to 17/-
Ordinary ,,	12/- to 14/-
Washed Nuts	25/- to 30/-
No. 3 Rhondda Large	28/- to 29/-
,, ,, Smalls	19/- to 20/-
No. 2 ,, Large	22/- to 23/-
,, ,, Through	18/6 to 21/-
,, ,, Smalls	12/- to 14/-
Coke (export)	35/- to 40/-
Patent Fuel	25/6 to 27/6
Pitwood (ex ship)	31/6 to 32/-
Swansea—	
Anthracite Coals:	
Best Big Vein Large	57/6 to 60/-
Seconds	47/6 to 50/-
Red Vein	40/- to 45/-
Machine-made Cobbles	65/- to 70/-
Nuts	70/- to 72/6
Beans	42/6 to 45/-
Peas	21/6 to 23/-
Breaker Duff	9/- to 9/6
Rubbly Culm	14/- to 14/6
Steam Coals:	
Large	24/6 to 25/-
Seconds	23/- to 24/-
Smalls	12/- to 14/-
Cargo Through	18/- to 23/-

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

The Exchange Rate.

The sudden rise in the exchange rate to more than 60f. to the £1 is causing a good deal of surprise and a certain amount of uneasiness in the sense that it implies an instability in the situation which may further retard the trade recovery. Nevertheless, there are certain interests which do not regard the depreciation of the franc with disfavour, since it is pointed out that the exchange will check the importation of British coal, iron and other materials which have been competing so severely with French productions, while the French themselves will be in a better position for doing business with Great Britain; but it is hopeless to expect to develop business between the two countries so long as there is the possibility of sudden depreciations in money values. During the past few months the franc appeared to have stabilised and was slowly improving, with the result that there was a certain degree of confidence which was favourable to a renewal of business. The fall in the value of the franc to near the record figure has weakened that confidence considerably. Still, the situation is by no means bad for French manufacturers, many of whom are profiting from the work of reconstruction in the devastated areas. The putting of the collieries into working order has necessitated the laying down of a vast amount of machinery and electrical plant, and such firms as Fives-Lille and Cail and Cie. have equipped a large number of sugar factories and refineries. Makers of steam generators and electrical machinery have been particularly busy, and have contracts that will keep them employed for some months. On the other hand, builders of railway rolling stock are waiting for orders which the companies are unable to give out until they obtain the necessary credits, and for the same reason nearly all the big public works are being held in abeyance. Nevertheless, the outlook has been much improved by the reconstruction activity in the devastated areas now that the Germans are to assist in the work.

Railway Rates.

At the time the State found it necessary to reorganise the railways on lines that would enable them to pay their way, instead of being a heavy burden upon the national treasury, one of the "reforms" carried out was the raising of railway charges. This was regarded as a temporary measure, and was strongly criticised on the ground that it would prove fatal to many industries. In some cases the freights were adjusted and special rebates were allowed on goods for export, as well as upon raw material for the shipbuilding industry. Still, the complaints that industrial activity is being stifled by the high charges have been growing in volume until the matter was discussed last week by the Superior Railway Council. As the temporary increase in rates was established to enable the companies to tide over a period of reorganisation when they would effect economies that would permit of their making substantial concessions to railway users, it follows that there can be no hope of relief until the work of reorganisation is completed. This was the position taken up by the Superior Railway Council, but the representatives of railway users were able to obtain an assurance from the companies that the rates would not, in any case, exceed three times the pre-war charges. The increase of working hours has done much to alleviate the situation of the companies, and serious economies are being carried out everywhere, with the result that the companies hope to find themselves in six months' time in a position to give at least partial satisfaction to users. The Superior Council therefore decided to maintain the present rates until May 1st next, when the matter will come up again for discussion.

Railway Conference.

The international services of trains on the Continent have become so hopelessly muddled since the Armistice through want of co-ordination, and more especially through the fluctuations of money values in different countries, that an international conference has been held in Paris, in pursuance of the recommendations of the Genoa Conference, to examine the situation and reorganise the international service on more practical lines. The programme before the conference was of a purely administrative character, the aims being to render the service at least as satisfactory as it was before the war and to solve the question of international railway charges with respect to the monetary fluctuations. The matter is to be dealt with by a permanent International Railway Union with headquarters in Paris. Monsieur Mange was elected President of the Union, and the three Vice-presidents will be selected by Great Britain, Germany and Italy. On the Management Committee all the countries are represented, with Sir William Forbes as the representative of Great Britain.

Dunkirk.

The Chamber of Commerce of Dunkirk has spent very large sums of money in equipping the port with a view of diverting from the north of France and Alsace-Lorraine the traffic that at present passes through Antwerp. Recently, representatives of the various industrial associations from Lille, Tourcoing and other centres were invited to visit Dunkirk, when they were able to see that the port installations are capable of dealing rapidly and economically with all that can be sent from the northern and eastern departments for export. The visitors were much struck by the enterprise shown by the Chamber of Commerce, but they regretted that they were unable to send their goods through Dunkirk because the railway and inland waterway charges from Lille, for example, were one-third more than the charges to Antwerp, although the distance to the French port is very much less. The railway company states that it is quite willing to make substantial reductions on the freights to Dunkirk if manufacturers will connect up their works with the railways by sidings and dispatch their goods by wagon loads. Makers reply that they are unable to incur this expense, and consequently Dunkirk is still waiting for the traffic which goes by Antwerp.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

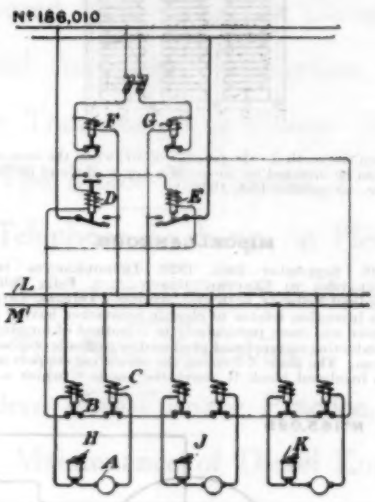
Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

SWITCHGEAR.

186,010. March 1st, 1922.—Electric Circuit Controllers, *The British Thomson-Houston Company, Limited*, 83, *Cannon-street, London, E.C.* 4.

One of the objects of this invention is to provide an improved arrangement, whereby when an overload occurs in a controlled electric circuit, the circuit is automatically opened and cannot be re-closed until the operator makes definite adjustments. Assume that an overload occurs in the circuit of the electric motor A. The overload relays B and C will be energised to open their respective contacts, and thereby de-energise the line switches D and E. As soon as the line switches D and E open, the overload relays B and C will return to their normally closed position, but the relays F and G will be energised to open their respective contacts, and thereby maintain the winding circuits of the line switches open until the motor controllers H, J and K have been returned to their respective off positions. In order

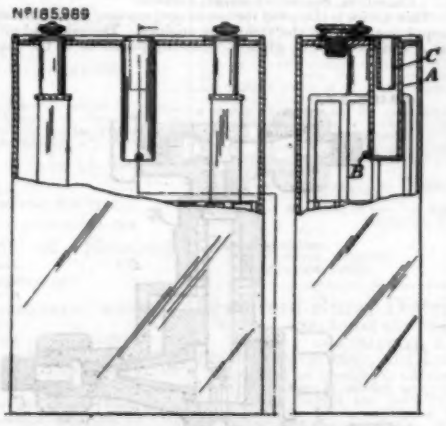


to reconnect the electric motors to the source of supply, it is necessary first to return all of the controllers to their respective off positions, thereby de-energising the relays F and G. If an overload has occurred on the circuit of the electric motor A, the controllers J and K may now be operated to energise their respective motors from the bus-bars L and M. If, for example, the overload in the electric motor A has been caused by a short-circuited winding, when this motor is again connected to the bus-bars L and M by the operation of the controller H, the line switches D and E will be automatically opened and maintained open until all the motor controllers have been returned to their respective off positions. In this manner, the defective circuit is easily found, so that the line switches D and E are operable to protect all of the controlled motors, and the motors which it is safe to operate may be operated while the dangerous condition in the one motor circuit is being remedied.—*September 21st*, 1922.

BATTERIES AND ACCUMULATORS.

185,989. November 2nd, 1921.—Accumulators, Three Star Accumulators, Limited, 54, Red Cross-street, London, and C. Kendall, 85, Crowland-road, South Tottenham.

This device aims at preventing the spilling of the electrolyte from storage batteries. It takes the form of a tube A, fixed in the cover, open at the top and closed below. A small open-

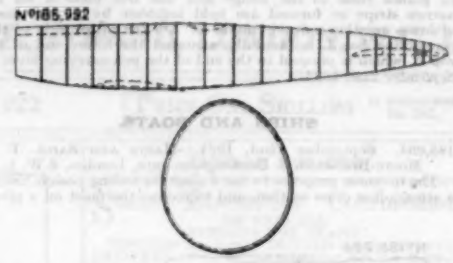


ing B is made in the side at the bottom. At the top there is another tube C, open at both ends, which leaves an annular space between itself and A. The level of the electrolyte is kept below the bottom of the tube A.—*September 21st*, 1922.

AERONAUTICS.

185,992. November 10th, 1921.—A Metallic Fuselage, H. O. Short, Norfolk Lodge, Borstal-road, Rochester.

This is a long specification covering the general structure of the body, or fuselage, for aeroplanes, the general characteristic of which is that it is mainly composed of a shell adapted to take the main stresses to which the fuselage is subjected, such shell being formed of a plurality of annular sleeves of sheet metal, brought together and overlapping each other at their adjacent edges, which latter are fitted in planes at right angles to the axis of the structure, the overlapping edges being riveted or

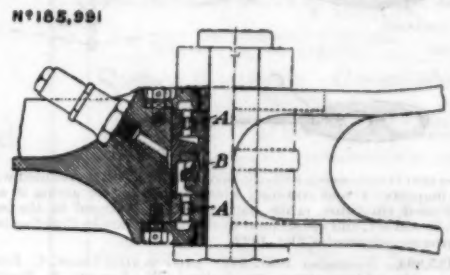


otherwise fixed together. Auxiliary strengthening devices are provided where necessary, and comprise rings of angle section metal arranged inside the shell and fixed thereto, and further longitudinal strengthening members can also be fitted interiorly within the shell and fixed thereto.—*September 21st*, 1922.

LOCOMOTIVES.

185,991. November 7th, 1921.—Valve Gear, H. N. Gresley Avenue House, Doncaster.

The inventor uses combinations of ball and roller bearings for the pivots of levers in the valve gear of three-cylinder locomotives, in order to overcome the difficulties which are experienced with plain bearings through the slackness caused by wear. The drawing reproduced shows the pivot for the large-motion



lever, in which the side thrust is taken by the roller bearings A A, while the weight is carried by the ball bearing B. All the bearings are enclosed in a grease-tight chamber. A somewhat similar arrangement is used for the pivot of the small-motion lever.—*September 21st*, 1922.

MEASURING AND TESTING INSTRUMENTS.

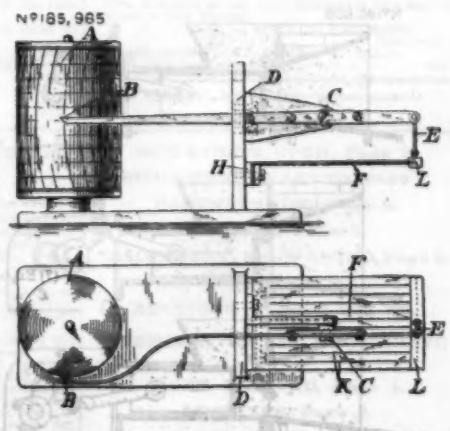
186,025. June 7th, 1921.—Spirit Levels, H. T. Tallack, 286, High Holborn, London, W.C.

In this specification the inventor states that hitherto the metal encasing tube of the glass bubble tube of surveying levels has always been cut open, so that both ends of the air bell may be seen for the purpose of enabling the user to see when the air bell is in the centre of its run. It has been considered necessary for the bubble to be truly adjusted so that it will reverse end for end in this position, but it really does not matter whether the bubble is in adjustment or not, as, if the air bell will remain

in any one position when reversed end for end, the vertical centre must be truly vertical. It is quite unnecessary to see both ends of the air bell to see if it is in the centre of its run, and the invention consists of opening the metal encasing tube of the glass bubble tube, so that only one end of the air bell can be seen. An index A is arranged to slide over the metal tube. In use, this index piece is simply placed at the position where the end of the air bell remains when reversed, and then if in setting up the instrument the end of the air bell is brought to the index pointer, the vertical centre will be truly vertical.—*September 7th*, 1922.

185,965. September 27th, 1921.—Thermographs, C. F. Casella and Co., Limited, and R. M. Abraham, 49 and 50, Parliament-street, London, S.W. 1.

This thermograph comprises a recording drum A of the usual type, over the surface of which moves a pen or style B, mounted



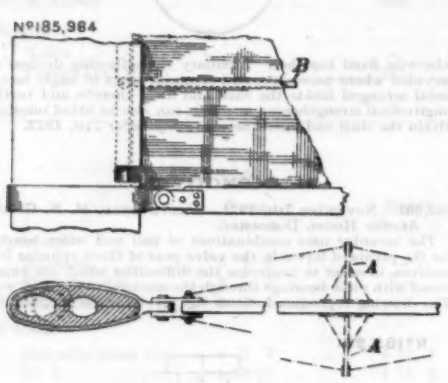
on the end of a long lever. This lever is pivoted at C to a standard D, and has pivoted to it at its further end a short rod E. A strip of compound metal F is formed by welding together two pieces of suitable metal, such as brass and steel, of the type known as "invar." This strip is then rolled out to the

desired thickness, is bent at right angles to itself near one end and the flange so formed is bolted to a bracket H on the standard D and heat insulated therefrom. The main body F of the sheet extends horizontally from the bracket as shown. Saw cuts K are made longitudinally in the sheet from its free end to points close to the flange and the free ends of all the narrow strips so formed are held together by a solid piece of brass or other suitable metal L. On the upper side of this connecting bar L is pivotally mounted the lower end of the rod E, which is pivoted to the end of the pen-carrying lever.—*September* 21*st*, 1922.

SHIPS AND BOATS.

185,964. September 22nd, 1921.—Masts and Sails, T. C. Moore-Brabazon, 3, Buckingham-gate, London, S.W. 1.

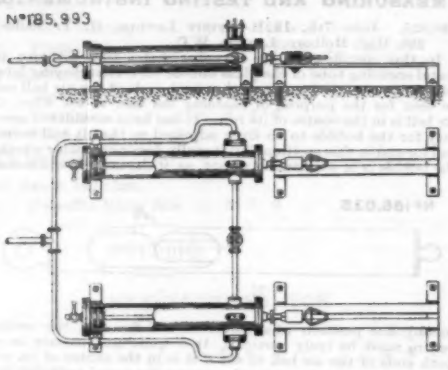
The inventor proposes to use a mast for sailing vessels having a stream-line cross section, and to mount the mast on a pivot,



so that it may swing with the boom. The boom is provided with kingposts A and straining wires, as shown, for giving it any desired curvature, while battens B are arranged in the sail, fore and aft, and are secured to the mast by knobs C sliding in a groove.—*September* 21*st*, 1922.

185,993. November 10th, 1921.—Launching Gear, C. Kidd, 45, Addison-street, Sunderland, W. Ranson, 8, Martin-terrace, Sunderland, and J. W. Wood, 5, Robinson-street, Sunderland.

The inventors propose to check the way of ships when they are launched by means of compressed air cylinders. The cylinders are shown in the drawing, and their arrangement is fairly obvious. They are charged with compressed air, and the shackles on the piston-rods are connected with the ship by wire

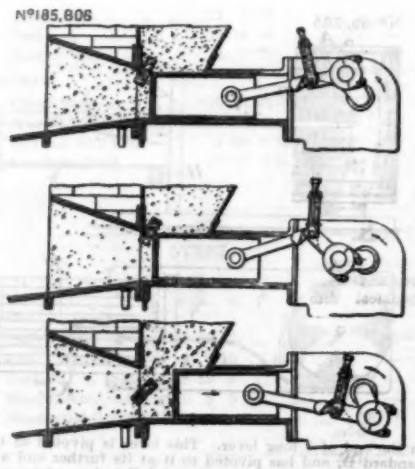


ropes running round pulley blocks, so as to provide for the extensive movement of the ship with comparatively short cylinders. As the air is further compressed in the cylinders by the movement of the ship, it is permitted to escape through safety valves.—*September* 21*st*, 1922.

FURNACES.

185,606. August 10th, 1921. Underfeed Stokers, *A. E. White, of White, Langner, Stevens and Parry*, 88–90, *Chancery-lane, London, W.C.* 2.

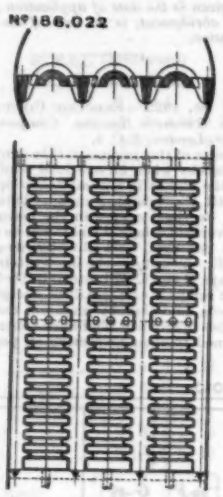
In this stoker feeding mechanism a joint, with a spring control



is arranged in the plunger connecting-rod so that, in the event of an obstruction taking place in the hopper opening, the rod will buckle at the joint and no damage will be done, while the feed will proceed normally so soon as the obstruction has passed. The arrangement is so obvious in the drawings as to need no description.—*September* 14*th*, 1922.

186,022. April 12th, 1921.—Fire-bars, R. Shenton, 21, Pendarvis-terrace, Seaside, Aberavon, Port Talbot, South Wales.

The inventor uses a series of semi-circular bars, as shown in the section, which have teeth that intermesh with corresponding teeth in the intervening wedge-shaped bars. There is space

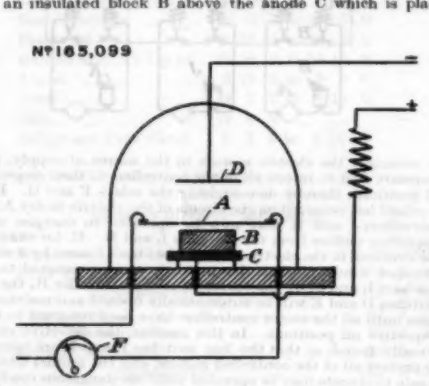


between the teeth for the passage of air, while the semi-circular bars can be inverted by means of a key at the end for cleaning the fire.—*September* 12*th*, 1922.

MISCELLANEOUS.

165,009. September 24th, 1922.—Improvements in and relating to Electric Resistances, Felix Pellin and Gabriel Pelletier, both of 5, Avenue d'Orléans, Paris.

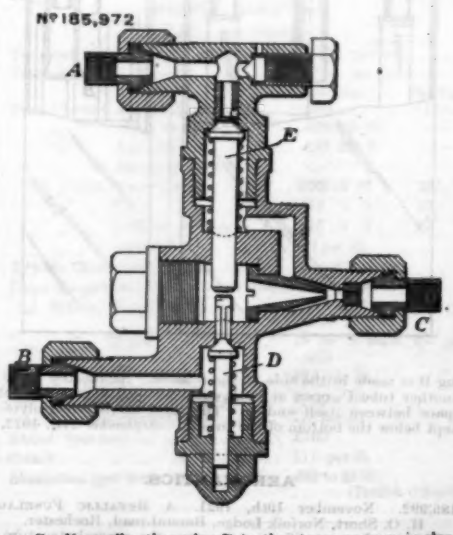
This invention relates to electric resistances having no self-induction and more particularly to a method of forming them, the conducting surface being produced by cathodic bombardment in vacuo. The plate A forming the insulating support is placed on an insulated block B above the anode C which is placed



beneath the metal cathode D and the whole is inserted in an exhauster. The potential used is about 1000 volts, the exhauster chamber being connected with a vacuum pump. When the required degree of vacuum is obtained the cathodic ray is formed and the reading of the measuring apparatus E is noted and the current shut off when the selected resistance has been obtained. The centre is then covered and the operation is continued at the edges with the same cathode or a different one for preparing the terminals.—*September* 4*th*, 1922.

185,972. October 7th, 1921.—Lubricators, The Hulburd Engineering Company, Limited, and M. W. Tutt, St. Benet Chambers, Fenchurch-street, London.

This device is intended for use in conjunction with lubricators supplying oil with the steam for engines. The oil is admitted at A and steam at B, while the mixture passes on to the engine



from C. Normally, the valve D in the steam passage is closed by the spring shown, but the oil pressure, acting on the valve E, pushes D open and thus admits steam. The result is that if the oil supply fails the steam is cut off.—*September* 21*st*, 1922.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

The Institution of Mechanical Engineers.—Storey's Gate, St. James's Park, S.W. 1. Extra General Meeting. Adjourned discussion on the "Use of the Turbo-Compressor for Attaining the Greatest Speeds in Aviation," by Professor Auguste Rateau. 6 p.m.

The Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Question and general discussion evening. 7.30 p.m.

Diesel Engine Users' Association.—The Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. "The Care and Maintenance of Diesel Engines." Non-members desirous of attending the meeting can make application for tickets of admission to the Honorary Secretary at 19, Cadogan-gardens, S.W. 3. 3 p.m.

The Institution of Civil Engineers: Yorkshire Association.—Philosophical Hall, Leeds. Presidential address by Lieut.-Colonel M. M. Bidder. 7.30 p.m.

The Institute of Metals: North-East Coast Local Section.—Armstrong College, Newcastle-on-Tyne. Paper: "The Production of Large Metallic Crystals and Some of their Properties," by Professor H. C. H. Carpenter. 7.30 p.m.

SATURDAY, OCTOBER 28TH.

The West Yorkshire Metallurgical Society.—George Hotel, Huddersfield. President's address. Lecture, "Growth and Deterioration of Cast Iron through Repeated Heating," by Mr. T. E. Hull. 6.30 p.m.

SATURDAY TO FRIDAY, OCTOBER 28TH TO NOVEMBER 3RD.

The Brewers' and Allied Traders' 30th Exhibition and Market at the Royal Agricultural Hall, London, N. 1.

MONDAY, OCTOBER 30TH.

Bradford Engineering Society.—Technical College, Bradford. Lecture, "The Oscilloscope and its Application," by Mr. A. J. H. Elverson. 7.30 p.m.

TUESDAY, OCTOBER 31ST.

The Institution of Automobile Engineers.—The Broadgate Café, Coventry. Meeting of the Coventry Graduates. Paper: "Automobile Steels and their Heat Treatment," by Mr. S. Philpot. 7.45 p.m.

The Association of Manufacturers of Non-corrodible and Anti-corrosive Products.—Room 1, Caxton Hall, Victoria-street, S.W. 1. Preliminary meeting. 2.30 p.m.

WEDNESDAY, NOVEMBER 1ST.

Institution of Railway Signal Engineers (Incorporated).—The Institution of Electrical Engineers, Savoy-place, Victoria Embankment, W.C. 2. Resumed discussion on Mr. T. S. Lascelles' paper, "Weissenbruch's Signal System on the Belgian State Railways." 3 p.m.

The Institution of Sanitary Engineers.—Holborn Restaurant, W.C. 1. Annual dinner. 7.30 p.m.

THURSDAY, NOVEMBER 2ND.

The Institution of Locomotive Engineers: Scottish Centre.—Visit to the works of G. and J. Weir, Limited, Holm Foundry, Cathcart. Party to meet at the works gate. 2.30 p.m.

The Institution of Locomotive Engineers: Scottish Centre.—Royal Technical College, George-street, Glasgow. Opening address by Mr. Walter Chalmers. 7.30 p.m.

Royal Aeronautical Society.—Royal United Service Institution, Whitehall, S.W. 1. Lecture, "A Review of Air-screw and Helicopter Theory with Aeroplane Analogies," by Major A. R. Low. 5.30 p.m.

The Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Inaugural address by Mr. Frank Gill. 6 p.m.

Northampton Engineering College Engineering Society (London).—St. John-street, Clerkenwell, E.C. 1. Paper: "Floating Docks," by Mr. Grixoni. 5.30 p.m.

FRIDAY, NOVEMBER 3RD.

The Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Extra general meeting. Lecture on "Repairs to the Roof of Westminster Hall," by Sir Frank Baines. 6 p.m.

The Association of Engineering and Shipbuilding Draughtsmen.—Memorial Hall, Farringdon-street, E.C. 4. "Adult Education," by Lord Haldane. 7 p.m.

The Junior Institution of Engineers.—39, Victoria-street, S.W. 1. Lecturette, "Laminated Springs," by Mr. T. H. Sanders. 7.30 p.m.

THURSDAY, NOVEMBER 9TH.

The Women's Engineering Society.—25, George-street, Hanover-square, W. 1. Lecture: "Research," by Mr. A. P. M. Fleming. 6.15 p.m.

Institution of Naval Architects.—The following scholarships in naval architecture and marine engineering have been awarded by the Council of the Institution of Naval Architects, viz.:—Naval architecture: Cammell-Laird Scholarship (£150 per annum), to Mr. S. W. Bolwell, of Messrs. Cammell Laird and Co., Birkenhead; Armstrong Scholarship (£150 per annum), to Mr. R. L. Hughes, of Messrs. Cammell Laird and Co., Birkenhead. Marine engineering: Parsons Scholarship (£150 per annum), to Mr. C. E. Moffatt, of H.M. Dockyard, Devonport; John Brown Scholarship (£150 per annum), to Mr. Donald Campbell, of Fairfield Shipbuilding and Engineering Company, Govan, Glasgow.

Institution of Production Engineers.—Members of the Institution of Production Engineers and their friends spent an interesting evening at the Royal Automobile Club on Friday last, on the occasion of the opening meeting of the session. This newest of engineering associations has been largely brought about by the intensive manufacturing conditions that prevail in the engineering world to-day. It exists primarily with the object of bringing manufacturing engineers into touch with one another, with a view to an interchange of ideas in the latest works practice. The gathering referred to was, therefore, somewhat unconventional, in that the more serious side of the engineering profession was less in evidence than is usual at affairs of this sort, and a very entertaining musical programme was included. After the reception, at which members were made acquainted with one another, there was a wireless concert, following which a short presidential address was delivered by Mr. Max Lawrence.